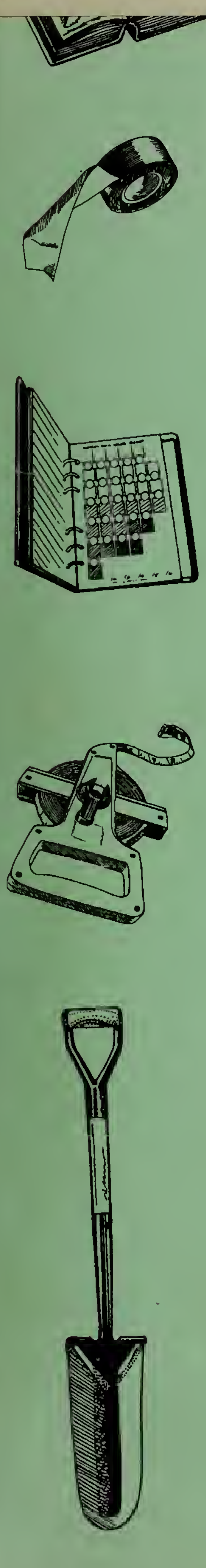
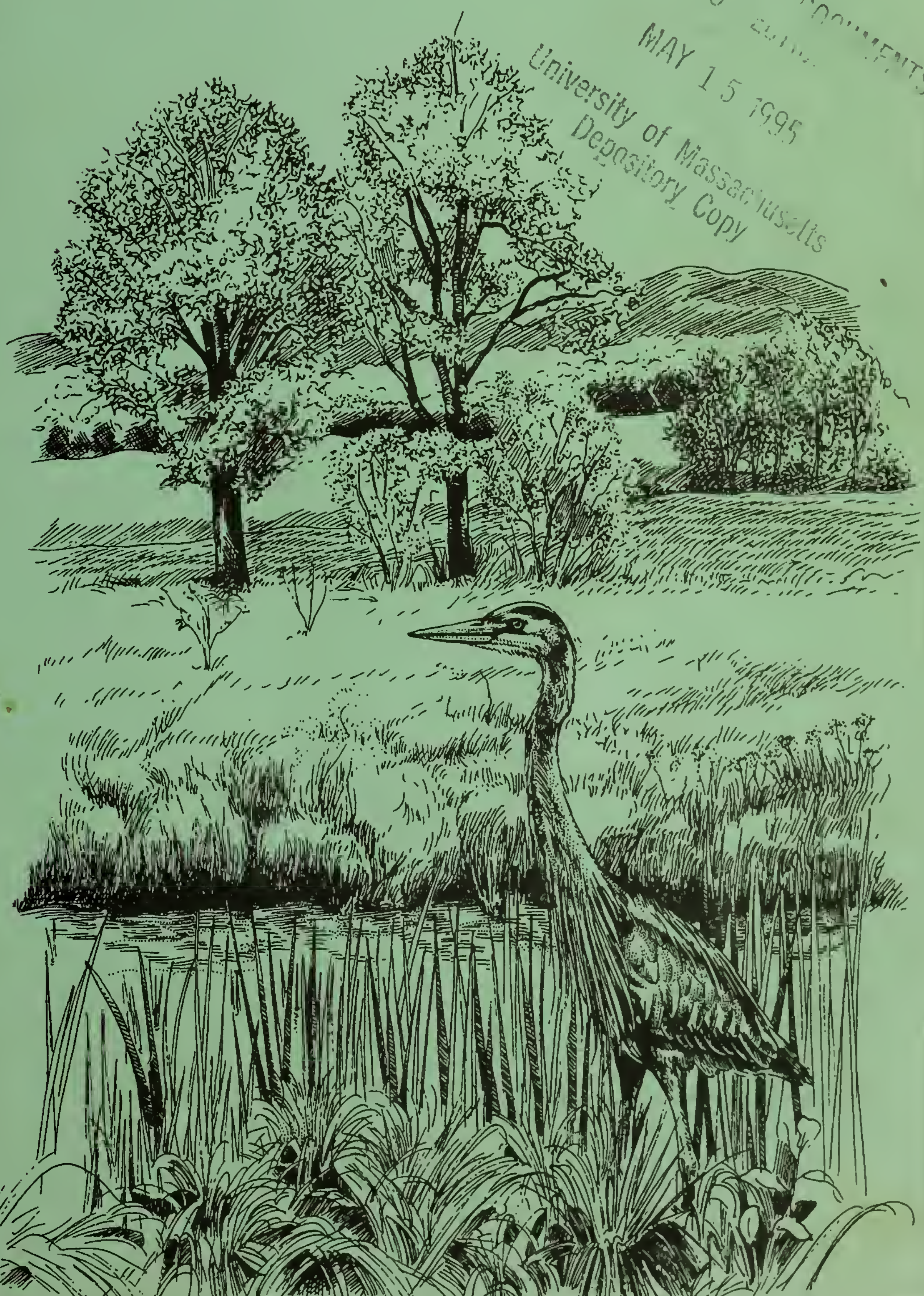


Delineating Bordering Vegetated Wetlands

Under the Massachusetts Wetlands Protection Act

MA Department of Environmental Protection
Division of Wetlands and Waterways



Delineating Bordering Vegetated Wetlands
Under the Massachusetts Wetlands Protection Act

A Handbook

March 1995

Produced by:
Massachusetts Department of Environmental Protection
Division of Wetlands and Waterways

Written by:
Scott Jackson
University of Massachusetts
Department of Forestry and Wildlife Management

Edited by:
Karen Walsh Peterson, Project Coordinator
Robert W. Golledge, Jr.
Richard Tomczyk
Massachusetts Department of Environmental Protection
Division of Wetlands and Waterways

Page Design and Layout: Karen Walsh Peterson
Handbook Illustrations: Nancy Haver
Marah Loft

Plant illustrations courtesy of Abigail Rorer, from *Freshwater Wetlands: A Guide to Common Indicator Plants of the Northeast* by D.W. Magee. 1981. University of Massachusetts Press, Amherst, MA and *Field Guide to Nontidal Wetland Identification* by Ralph Tiner, Jr. 1988. Maryland Department of Natural Resources, Annapolis, MD and USFWS.

DEP

Dept. of Environmental Protection
Division of Wetlands and Waterways
One Winter Street
Boston, MA 02108

Commonwealth of Massachusetts
Executive Office of Environmental Affairs

Department of Environmental Protection

William F. Weld
Governor
Trudy Coxe
Secretary, EOEA
Thomas B. Powers
Acting Commissioner

PREFACE AND ACKNOWLEDGEMENTS

March 1995

Over the past few years, the Department of Environmental Protection has undertaken a number of initiatives aimed at improving the efficiency of the wetlands permitting process while increasing the overall level of protection for the most critical resource areas. The wetlands delineation regulation and this handbook are one part of a three-part "Less Process - More Protection" strategy for assuring a strong, common sense, and efficient approach to wetlands protection in Massachusetts.

The revision to the delineation regulation and the development of this handbook grew out of the Wetlands Task Force, a group of environmentalists, builders, and consultants who came together to figure out how to improve wetlands permitting procedures while maintaining a high level of protection. The Task Force established a wetlands delineation subcommittee which took on this task with a tremendous degree of commitment and professional knowledge.

Differences over wetlands boundaries have been one of the most frequently disputed issues in the wetlands protection permitting program. Inaccurate delineations can lead to unnecessary wetlands losses or delays in project designs and permitting. Armed with better science, and more tools to make accurate field assessments, conservation commissioners and the development community alike should be able to reduce the number of wetland boundary disputes and ensure that the wetland boundaries are accurate. Both project design and wetlands protection will benefit from these improvements.

To protect Bordering Vegetated Wetlands (BVWs) and the public interests they provide, the boundaries of these resource areas need to be accurately delineated. The Department revised the wetlands protection regulations (310 CMR 10.55) to incorporate hydrology, often indicated by hydric soils, along with vegetation into the boundary determination in certain situations. The new delineation method will improve wetlands protection, increase the effectiveness of permitting, and promote statewide consistency - goals we all share.

One Winter Street • Boston, Massachusetts 02108 • FAX (617) 556-1049 • Telephone (617) 292-5500

The Division of Wetlands and Waterways is committed to helping conservation commissioners and others understand and apply the new regulations and procedures. As part of that effort, we have produced this handbook, *Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act*. The handbook provides background information on wetland processes, procedures for delineating BVW boundaries, and recommendations for reviewing boundary delineations. In addition, the handbook includes a field data form for delineations. However, to be effective, the information you read in this document must be practiced in the field.

The Department acknowledges the commitment and hard work that has gone into the development of the revised regulations and this handbook by many individuals and organizations, including those listed on the next page.

Sincerely,

Arleen O'Donnell
Acting Deputy Commissioner
Department of Environmental Protection

Carl F. Dierker
Acting Director
Division of Wetlands and Waterways

The Department of Environmental Protection acknowledges the contributions of the members of the Wetlands Delineation Advisory Committee in the development of the wetlands protection regulatory revisions, BVW policy, and this handbook:

Wetlands Delineation Advisory Committee

Gary R. Sanford - Sanford Ecological Services
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Sources of Information Used in this Handbook

The following sources were used in the compilation of this handbook:

Hydric Soils of New England by R.W. Tiner, Jr. and P.L.M. Veneman. 1987. University of Massachusetts Cooperative Extension, Amherst, MA. Bulletin C-183.

"Field Recognition and Delineation of Wetlands" and "Problem Wetlands for Delineation" by R.W. Tiner, Jr., in *Wetlands: Guide to Science, Law, and Technology* by M.S. Dennison and J.F. Berry. 1993. Noyes Publications, Park Ridge, NJ.

National List of Plant Species that Occur In Wetlands: Massachusetts by P.B. Reed, Jr., 1988. U.S. Fish and Wildlife Service, Washington, DC.

The Concept of a Hydrophyte for Wetland Identification by R.W. Tiner, Jr. 1991. BioScience 41(4):236-247.

Field Guide for Delineating Wetlands: Unified Federal Method. 1989. Wetland Training Institute, WTI 89-1.

Corps of Engineers Wetlands Delineation Manual by Environmental Laboratory. 1987. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Technical Report Y-87-1.

Hydrologic cycle diagram (page 4) from *An Introduction to Groundwater and Aquifers.* Groundwater Information Flyer #1. 1983. Massachusetts Audubon Society, Lincoln, MA.

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Table of Contents

INTRODUCTION

Conservation commissioners in Massachusetts have a unique knowledge of the local landscape and the important functions that wetlands provide in their community, such as flood control and wildlife habitat. As a result, commissioners play an important role in protecting these wetland resource areas because their knowledge is incorporated into the permitting process at the local level.

In fact, the majority of permitting requirements under the Wetlands Protection Act ("The Act," Massachusetts General Laws, Chapter 131, Section 40) are administered by conservation commissions. For this reason, the Department of Environmental Protection (DEP) and its Division of Wetlands and Waterways (DWW) are committed to providing commissions with the training and tools necessary to implement the Act. The first and often the most important step in protecting wetlands is identifying their location in the field.

Freshwater wetlands bordering on creeks, rivers, streams, ponds, or lakes are protected by the Act. Four wetland types are identified in the Act: bogs, swamps, marshes, and wet meadows. Generally, these are areas where groundwater is at or near the surface, or where surface water frequently collects for a significant part of the growing season, and where a significant part of the vegetative community is made up of plants adapted to life in saturated soil. The ground and surface water conditions and plant communities which occur in each of these wetland types are specified in the Act. Hydrology (water) and vegetation (plants) are the two characteristics that define freshwater wetlands protected by the Act.

Bogs, swamps, marshes, and wet meadows that border on water bodies are defined in the Wetlands Protection Act regulations (310 Code of Massachusetts Regulations 10.55) as Bordering Vegetated Wetlands (BVWs). The regulations define BVWs as areas where the soils are saturated or inundated such that they support plants that are adapted to periodically wet conditions.

BVWs provide important benefits to landowners and the general public. These benefits include: protection of public and private water supply, protection of groundwater supply, flood control, storm damage prevention, prevention of pollution, protection of fisheries, and protection of wildlife habitat. Proper identification and delineation of BVWs are essential to preserve the important functions and values they provide.

Wooded Swamp

BVW Regulation & Policy

In 1995, DEP revised its regulations to provide a more scientifically-based definition and delineation procedure for BVWs that incorporates hydrology into the boundary determination. The revised definition and procedures contained in this handbook are consistent with the Act. The new regulations define wetland indicator plants, specify when delineations may be based on vegetation alone, and clarify when vegetation and indicators of hydrology should be used to delineate the BVW boundary. The new regulations also provide greater consistency between the state's Wetlands Protection Program and 401 Water Quality Certification Program, which is administered by the Division of Wetlands and Waterways using regulations at 314 CMR 9.00. The BVW regulatory revisions (310 CMR 10.55) become effective June 30, 1995.

Wetlands Protection Program Policy: Bordering Vegetated Wetlands Delineation Criteria and Methodology recommends a procedure for vegetation analysis and provides guidance to applicants and conservation commissions on how to delineate the boundary of a BVW. The definitions and procedures provided in the new regulations and policy are intended to provide greater consistency in BVW delineation statewide.

Handbook Contents

Since the overall success of wetlands protection efforts relies on accurately identifying wetlands, DEP has developed this handbook. The handbook provides background information on wetland processes and the regulatory framework, procedures for delineating BVW boundaries, and recommendations for reviewing boundary delineations presented to conservation commissions. This handbook also provides a field data form for delineations (see Appendix G).

Chapter One introduces wetland hydrology as the driving force that creates and maintains wetlands. The physical and chemical conditions that are caused by frequent saturation are discussed. The characteristics of wetland soils and vegetation that make them important wetland indicators also are presented.

Chapter Two discusses wetland vegetation. This chapter covers plant classification, methods of measuring plant abundance, and procedures for assessing vegetative communities, primarily the dominance test.

Chapter Three presents delineation criteria. In particular, information is provided on when vegetation alone may be used to delineate BVWs and when vegetation and hydrology should both be used.

Chapter Four discusses various indicators of hydrology and how to recognize them in the field. A large part of this chapter deals with soils - a reliable indicator of wetland hydrology. Procedures for evaluating soils are included. Other indicators of hydrology, such as water marks and water-stained leaves, also are discussed.

Chapter Five describes procedures for delineating BVWs in the field. Procedures are provided for boundary delineations based on vegetation alone, as well as delineations that use vegetation and hydrology (with soils as a reliable indicator of hydrology). This chapter also provides recommendations for reviewing delineations.

Appendices are included at the end of this handbook, providing resource information and examples of how vegetation analyses are used to evaluate plant communities. Also included is a glossary of terms.

Summary

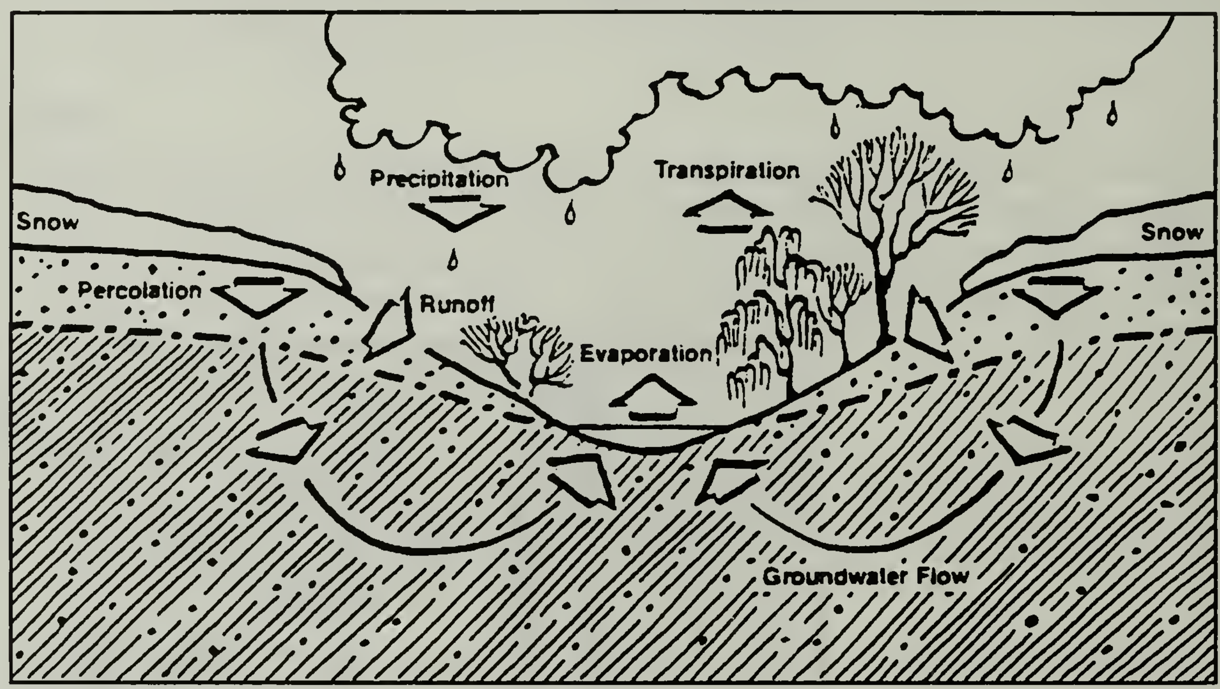
In many cases, BVW delineation is relatively simple, and can be accomplished without detailed measurements and calculations. Where an abrupt change in plant communities and slope occurs, delineations may be done visually, using vegetation and topography to determine the BVW boundary. More complex sites may require the use of soil indicators or other evidence of hydrology, along with an analysis of vegetative communities, to determine BVW boundaries. To select delineation procedures that are appropriate for a particular site, it is important to become familiar with wetland indicators and how they are used to delineate BVWs.

This handbook provides a great deal of information about BVW delineation. Much of it is background information intended to help foster greater understanding of the processes that produce wetland indicators and how those indicators may be used to determine BVW boundaries. Procedures are presented as step-by-step instructions with numerous graphics and examples. The best way to become familiar with these procedures is to use them in the field.

CHAPTER ONE
Hydrology

The properties, distribution, and circulation of water is commonly referred to as hydrology. Wetland hydrology refers to the movement of water within and through a wetland. Hydrologic features such as the frequency, timing, depth and duration of inundation, water table fluctuations, and the movement of ground and surface water are the driving forces behind all wetland systems.

Water in a wetland may be surface water, groundwater, or a combination of the two. Both surface water and groundwater may lead to saturated conditions that after a length of time will create wetlands. Saturation occurs when the soil has all or most of its pores within the root zone filled with water.



The hydrologic cycle *Source: Massachusetts Audubon Society, 1983.*

Surface Water

Inundation is the ponding of surface water runoff or flooding from adjacent water bodies. The surface water may infiltrate into the ground, a process called percolation. Periodic and lengthy inundation creates saturated conditions.

Groundwater

Groundwater is often found at or near the ground surface during the wetter seasons of the year. The water table is a term that is commonly used to describe the upper limit or depth below the surface of the ground that is completely saturated with water. The water table can fluctuate throughout the year so that saturated conditions may be seasonally present.

Groundwater also occurs in areas of soil above the water table due to capillary action, a process where water is drawn up through pores in the soil. This area of nearly saturated soil above the water table (which is a couple of inches thick or thicker) is called the capillary fringe. Wetland conditions may develop in areas where groundwater occurs at or near the surface during the growing season, even if water is not visible at the surface.

Anaerobic Conditions

Soils that are saturated during the growing season, either due to a high water table or inundation by surface water, develop conditions where no oxygen is readily available for use by plants and microbes. These are known as anaerobic conditions. Under saturated conditions, plants and microbes use available oxygen faster than it is replaced. The rate at which oxygen is depleted depends on the amount of biological activity in the soil. Biological activity, in turn, is affected by soil temperature and the amount of organic matter in the soil. The presence of anaerobic conditions is essential for wetland development.

Growing Season

It is not just the presence of saturation and anaerobic conditions, but the presence of these conditions during the growing season, that is important. The growing season is the part of the year when soil temperatures are high enough to support biological activity (above biological zero or 41 degrees Fahrenheit, 4 degrees centigrade). In Massachusetts, the growing season generally extends from March to November.

Water can be present for relatively long periods of time during the winter without having a significant impact on plants or soils. This is because there is little biological activity in the soil during the colder months of the year. Soils that are saturated or inundated during the winter may never become anaerobic; or if they do, plants may be dormant and therefore not affected by anaerobic conditions. During the growing season, however, wetland soils can become anaerobic after a relatively brief period of saturation or inundation.

Length of Saturation

The length of saturation needed to produce anaerobic conditions varies among wetlands and is dependent, in part, on soil type. As a general rule, anaerobic conditions can develop in as little as 7 to 21 days of saturation during the growing season. These anaerobic conditions during the growing season produce plant communities and soil characteristics in wetlands that differ from plants and soils in uplands. Plants that are able to tolerate anaerobic conditions in the soil generally grow in wetlands. Different plants are adapted to longer or shorter periods of inundation or saturation, but all have adaptations that allow them to cope with regular periods of saturation. These plants may be referred to as hydrophytes.

Indicators of Hydrology

Although water is the driving force behind wetlands, it is not always possible to directly observe hydrology or use it to delineate BVW boundaries. Inundated or saturated conditions may only be present in a wetland for a short period of time during the year, and even this pattern is subject to climatic conditions that can produce very wet or very dry years. Even if hydrology is monitored in an area, it can be difficult to equate the patterns of inundation or saturation with the presence or absence of anaerobic conditions. Soil characteristics and plant communities generally are present throughout the year and are the most reliable indicators of hydrologic conditions.

Since the presence of wetland plants (hydrophytes) and wetland soils (hydric soils) are the most reliable indicators of the hydrology of an area, under natural conditions they are more useful for delineating BVW boundaries than hydrology itself. Other features, such as water marks on trees and water-stained leaves, also are indicators of hydrology. However, it is often difficult to determine the duration or frequency of saturation from these indicators. DEP recommends that all available information be used when evaluating hydrology.

CHAPTER TWO
Wetland Vegetation

Wetlands range in wetness from areas that are permanently flooded to those that are only saturated or inundated for relatively brief times during the growing season. Plants have evolved adaptations for life in a wide range of wet conditions resulting in plant species that demonstrate varying degrees of affinity for wet habitats. Although some species grow only in habitats that are wet year-round, most wetland plants are able to tolerate a range of hydrologic conditions and may occur in uplands as well as wetlands. Plant species that typically occur in wetlands and generally are good indicators of wetland hydrology are considered "wetland indicator plants."

Plant Classification

All plants, whether wetland or upland, are classified according to their natural relationships and genealogy, and are organized into various groups (Kingdom, Division, Subdivision, Order, Family, Genus, Species). These groups range from broad (Kingdom) to narrow (Species). A scientific name is given to plants that would produce similar offspring. The scientific name includes the genus name and the species name. In the case of the plant winterberry, *Ilex* is the genus name and *verticillata* is the species name. Plants also have common names. However, a common name is not as reliable a label to use since one plant may have more than one common name, or a common name may be used to identify different plants. For example, a plant that has one scientific name, *Ilex verticillata*, may have more than one common name; in this case, winterberry also may be called black alder. Under this classification system, plants also are grouped into families. *Ilex verticillata* is a member of the holly family (Aquifoliaceae). To avoid confusion, the scientific name of a plant should be used when describing the plants present at a site.

The U.S. Fish and Wildlife Service's National List of Plant Species That Occur in Wetlands (Reed, 1988) is a comprehensive list that was assembled by scientists from the U.S. Fish and Wildlife Service (USFWS), Environmental Protection Agency (EPA), Army Corps of Engineers (COE), and Natural Resources Conservation Service (NRCS), with the help of regional botanists and ecologists. The National List uses a common name and the scientific name for each plant and classifies each plant based on the frequency or the percentage of time that it is found in wetland versus upland conditions. The plants are assigned to one of five major categories (called indicator category) based on their frequency of occurrence in wetlands versus uplands. According to the wetlands regulations (310 CMR 10.55), any plant in the National List with an indicator category of Obligate, Facultative Wetland, or Facultative are wetland indicator plants. Plants in the National List also are categorized according to their national and regional indicator category. For delineating BVWs in Massachusetts, the indicator category from the Massachusetts list should be used.

Plants species that almost always grow in saturated or inundated conditions during the growing season (>99% of the time) are classified as **obligate wetland** species (also called "obligate" species and abbreviated OBL). Examples include skunk cabbage (*Symplocarpus foetidus*), broadleaf cattail (*Typha latifolia*), and buttonbush (*Cephalanthus occidentalis*).

Skunk cabbage
(*Symplocarpus foetidus*)
OBL

Species that are tolerant of flooding or saturation during the growing season and are adapted to live in a variety of wet or dry conditions are assigned to one of three facultative categories, depending on how frequently they are observed in wetlands.

speckled alder
(*Alnus rugosa*)
FACW+

Facultative wetland plants usually occur in wetlands (67-99% of the time), but are occasionally found in uplands. These are typically referred to as "fac-wet" species (abbreviated FACW). Examples include silver maple (*Acer saccharinum*), speckled alder (*Alnus rugosa*), and sensitive fern (*Onoclea sensibilis*).

Facultative plants sometimes occur in wetlands (34-66% of the time), although they may be equally likely to occur in uplands. These are typically referred to as "fac" species (abbreviated FAC). Examples include yellow birch (*Betula alleghaniensis*), sheep laurel (*Kalmia angustifolia*), and interrupted fern (*Osmunda claytoniana*).

sheep laurel
(*Kalmia angustifolia*)
FAC

Facultative upland plants usually occur in uplands and are seldom found in wetlands (1-33% of the time). These are typically referred to as "fac-up" species (abbreviated FACU). Examples include red oak (*Quercus rubra*), princess pine (*Lycopodium obscurum*), and multiflora rose (*Rosa multiflora*).

Plants that rarely occur in wetlands (have less than a one percent probability of occurring in wetlands) are considered **upland** species (abbreviated UPL). Any plants not included in the National List are considered upland plants.

The FACW, FAC, and FACU categories are further refined by the addition of a "+" or "-" sign to more specifically define the regional frequency of occurrence in wetlands. A "+" sign indicates a frequency toward the wetter end of the category (more frequently found in wetlands). A "-" sign indicates a frequency toward the drier end of the category (less frequently found in wetlands).

multiflora rose
(*Rosa multiflora*)
FACU

USFWS Indicator Categories

Occurrence In Wetlands

Category	Abbreviation	Descriptor	Frequency in Wetlands
Obligate wetland	OBL	almost always	> 99%
Facultative wetland	FACW	usually	67-99%
Facultative	FAC	equally likely to occur	34-66%
Facultative Upland	FACU	seldom	1-33%
Upland	UPL	rarely	< 1%

Wetland Indicator Plants

As previously described, plant species that typically occur in wetlands and generally are good indicators of wetland hydrology are considered "wetland indicator plants." Wetland indicator plants are defined in the wetlands protection regulations as any of the following:

1. **Plant species listed in the Wetlands Protection Act (see Appendix A).** The Wetlands Protection Act lists plants by a common name and one of the following: family name, genus name, or species name. (Note: the species name, also known as the scientific name, is made up of the genus and species.) The list in the Act is general and is not meant to include all plants that occur in wetlands. Also, some plants are listed only by family or genus. These are broad categories that include wetland plants as well as non-wetland plants. For instance, the family Juncaceae is comprised of many rushes of which only some are wetland indicator plants. Also, the genus Fraxinus (ashes) includes wetland plant species (green ash, *Fraxinus pennsylvanica*; black ash, *Fraxinus nigra*), as well as a non-wetland plant (white ash, *Fraxinus americana*). As a result, DEP has determined that the plants listed in the Act only by scientific name (plants with a genus and species name) are considered wetland indicator plants. Plants listed in the Act by family or genus only must also meet criterion #2 below to be considered wetland indicator plants. **In addition, all plants in the genus *Sphagnum* are considered wetland indicator plants** (species in this genus have not yet been categorized by indicator category).

2. **Plants listed in the National List with an indicator category of OBL, FACW+, FACW, FACW-, FAC+, and FAC.**

3. **Individual plants that exhibit morphological or physiological adaptations to life in saturated or inundated conditions.** Morphological adaptations are evident in the form or shape of a plant, such as shallow root systems (see page 36). Physiological adaptations are related to a plant's metabolism and generally are not observable without the use of specific equipment or tests. Plants with indicator categories of UPL, FACU, or FAC- that exhibit adaptations to life in saturated conditions can be considered wetland indicator plants (i.e., White pine, *Pinus strobus*, FACU, with buttressed trunks and shallow roots).

Only plants that meet these criteria should be considered wetland indicator plants.

Plant Identification

Plant identification is an important aspect of reviewing or delineating BVW boundaries. In addition to being able to identify a number of wetland indicator plants, it is also important to be able to recognize them at different times of the year. In winter, twigs and buds possess important characteristics that aid in the identification of woody plants. Many herbaceous plants die back during the winter and are unavailable for identification. In the spring, it is important to be able to identify the early growth stages of plants, such as the fiddleheads of ferns or the flowers of skunk cabbage (*Symplocarpus foetidus*). During the growing season, leaves, flowers, fruits, nuts, catkins, and seeds are available for inspection. Some plants, such as grasses and sedges, can only be identified when they are in flower or when seeds are present.

A variety of field guides are available to help with identification. Some focus on particular plant groups, such as ferns, grasses, trees, or shrubs. Others contain keys (identification guides) to various characteristics of plants (twigs, fruit, leaves, flowers). Although it is useful to be able to recognize common plants in the field, it is also important to learn how to use field guides to identify plants (see Appendix E for a list of recommended field guides).

Assessing Vegetative Communities

Although the ability to identify individual plant species is an important skill, it is also important to consider the plant community when reviewing or delineating BVW boundaries. The Wetlands Protection Act specifies that a "significant part of the vegetational community" must be made up of wetland plants. The wetlands protection regulations define Bordering Vegetated Wetlands as areas where 50 percent or more of the vegetative community consists of wetland indicator plants. Therefore, "significant part" means "50 percent or more." In order to evaluate whether there are 50 percent or more wetland plants in an area, it is necessary either to estimate or measure their abundance.

In many cases, vegetative communities can be assessed without using a specific assessment methodology. If the wetland/upland boundary is abrupt or discrete, a simple walk through a site may be used to characterize communities as either wetland or upland. In other cases, such as where there are large transition zones or gently sloping topography, the use of a more detailed delineation procedure, including a method for assessing vegetative communities, will be needed.

DEP uses the following methodology in reviewing delineations, and recommends its use by applicants and conservation commissioners when detailed measurements and calculations are needed. DEP also has developed a field data form to document site information when determining a BVW boundary.

DEP Field Data Form

The DEP field data form should be submitted with a Request for Determination of Applicability or Notice of Intent. The field data form and instruction sheet are included in Appendix G. The form is compatible with the methodologies described in this handbook. Information on the site's vegetation and hydrology can be recorded. The section on vegetation allows the delineator to document plants that make up a significant portion of the vegetative community and whether any of the non-wetland indicator plants have special adaptations that would make them wetland indicator plants.

The field data form also includes a section on hydrology. In this section, information about observed hydrologic conditions (flooded conditions or groundwater) and any other indicators of hydrology, such as hydric soils, can be recorded.

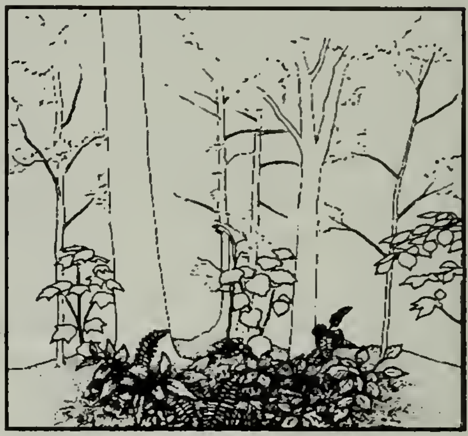
By using the data form, site information can be presented in a standard format. The delineator can describe the conditions which led to his or her conclusion that the site is a BVW or not. The reviewer can use the form to prepare to inspect the boundary in the field. For instance, if a reviewer is unfamiliar with a plant or an indicator of hydrology, reference materials such as field guides can be consulted before the field assessment.

Measuring Plant Abundance

Vegetative Layers

Plants within vegetative communities are divided into strata, or layers, for analysis. Five layers are used in this assessment: ground cover, shrub, sapling, climbing woody vine, and tree.

The **ground cover** layer includes woody vegetation less than 3 feet in height (seedlings), non-climbing woody vines less than 3 feet in height, and all non-woody vegetation (herbs and mosses) of any height. (See dark areas in illustration.)



Shrubs are woody vegetation greater than or equal to 3 feet, but less than 20 feet in height. (See dark areas in illustration.)

The **sapling** layer includes woody vegetation over 20 feet in height with a diameter at breast height (dbh) greater than or equal to 0.4 inches to less than 5 inches. Diameter at breast height is measured 4.5 feet from the ground. (See dark areas in illustration.)

Trees are woody plants with a dbh of 5 inches or greater and a height of 20 feet or more. (See dark areas in illustration.)

Note: climbing woody vines are a separate vegetative layer.

Observation Plots

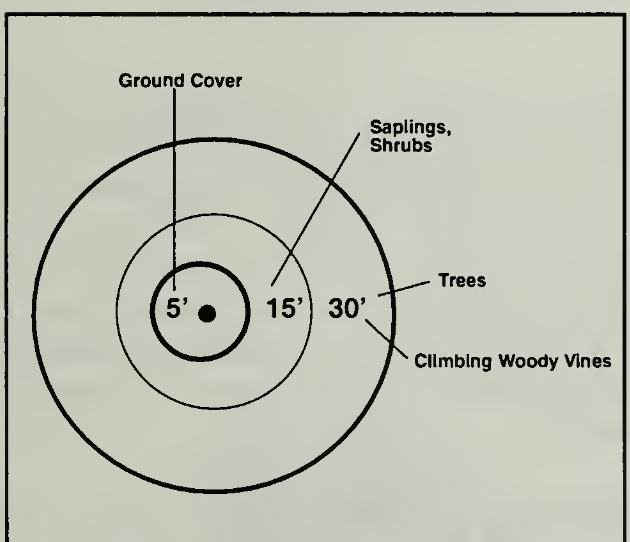
Observation plots are used for measuring or estimating plant abundance. The number of plots should be based on the complexity of the site. Plots generally should be located in vegetative communities that are not clearly wetland or upland. Plot locations should be chosen so that the vegetation within the plot is representative of the vegetation within the community as a whole. Circular plots with the following dimensions are recommended:

Circular plot dimensions:	
Ground cover:	5 foot radius
Shrubs:	15 foot radius
Saplings:	15 foot radius
Climbing woody vines:	30 foot radius
Trees:	30 foot radius

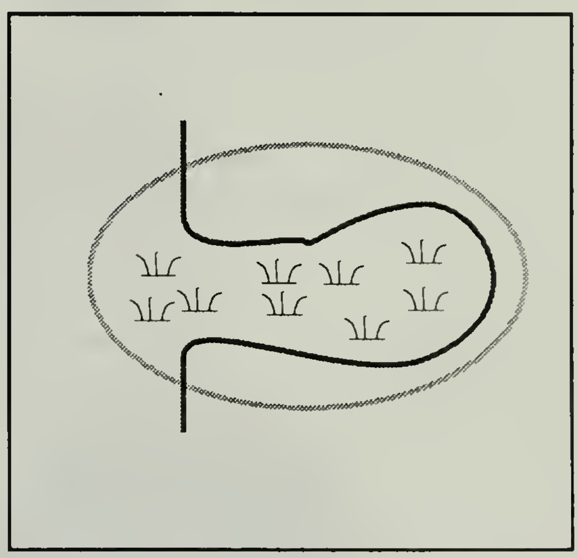
However, plot size and shape may be varied when site conditions warrant. Plot locations may need to be adjusted to ensure that the vegetative layer being sampled is representative of the plant community.

At the site, do a quick check of the vegetation and identify the layers involved. When choosing your plots, be sure that the vegetation in your sample is representative of the vegetation in that layer as a whole. From a central location (using a tape measure), measure circular plots to the size noted for each layer. Tie flags in the vegetation to mark the boundaries of your circular plots.

As you become more comfortable and experienced doing this analysis, you will be able to estimate plot sizes. You should begin your assessment with the ground cover layer (if present) before you trample the vegetation. With the observation plots marked, you can now evaluate plant abundance for each layer and species in the plot using percent cover.



Standard circular plots



Plot locations may need to be adjusted to reflect site conditions, such as in the case of an oblong wetland.

Percent Cover

Percent cover is a simple method for evaluating plant abundance and can be used for all layers (ground cover, shrub, sapling, climbing woody vine, and tree). Basal area also may be used to evaluate tree abundance (see Appendix B). Percent cover is the percent of the ground surface that would be covered if the foliage from a particular species or layer were projected onto the ground, ignoring small gaps between the leaves and branches. Foliage from different individual plants in the same layer can overlap, and as a result, total percent cover may exceed 100 percent.

Percent cover can be estimated visually or it can be measured using techniques such as the point-intercept or quadrat sampling methods (for more information about these techniques, consult the 1989 *Federal Manual for Identifying and Delineating Jurisdictional Wetlands*). For many sites, however, a visual estimation of percent cover may yield an accurate result. The accuracy should improve as you become more familiar with the method.

To visually estimate percent cover in the field, it is necessary to be able to focus your attention on one layer, and often, one plant species within the layer. Visual estimates of percent cover can be highly variable when observations from different individuals are compared. This variability can be reduced by using cover ranges. The following cover ranges should be used when estimating percent cover. If you use cover ranges, you should use the midpoint values noted below for analyses of vegetative communities.

Cover Ranges

Range	Midpoint
1-5%	3.0
6-15%	10.5
16-25%	20.5
26-50%	38.0
51-75%	63.0
76-95%	85.5
96-100%	98.0

It may be useful to ask a series of questions when estimating percent cover. Is the percent cover for the species greater than 5 percent? If so, is it greater than 15 percent? 25 percent? 50 percent? Once you've answered "no" to a particular threshold, you have identified the cover range: the range directly below the threshold that was not exceeded. You should then use the midpoint value to identify the percent cover for that plant species. For example, if the cover range of 26 to 50 percent is selected, the midpoint value of 38.0 percent will be used. Using cover ranges and midpoint values will reduce the variability of results from different people. (See examples of percent cover, cover ranges, and midpoint values on page 13.)

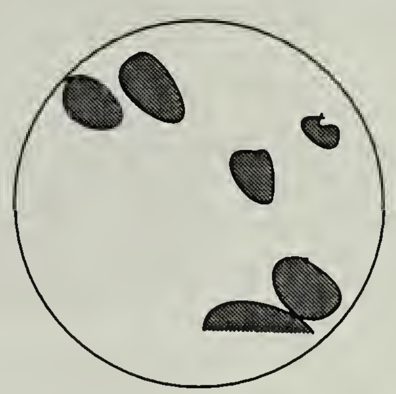
When estimating or measuring percent cover, include any foliage in the layer that occurs in the observation plot only if the stem or trunk of the plant originates within the plot. When using basal area to estimate abundance for the tree layer, include only those trees whose trunks originate within the plot.

Plant abundance should be estimated or measured for each layer where the total percent cover is 5 percent or greater. All vegetative layers present in an observation plot must be reported in the evaluation unless the total percent cover of a layer is less than 5 percent. Within each of those layers, estimate or measure plant abundance for each species. Any plant species with 1 percent cover or less should not be included. Once you have measured or estimated plant abundance in each layer, the dominance test should be used to assess whether the vegetative community includes 50 percent or more wetland indicator plants.

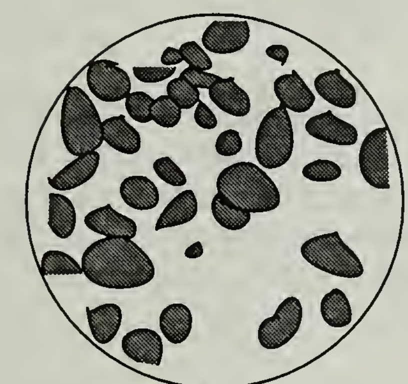
Examples of Percent Cover, Cover Ranges, and Midpoint Values

The following are examples of percent cover estimates with the associated cover range and midpoint value noted.

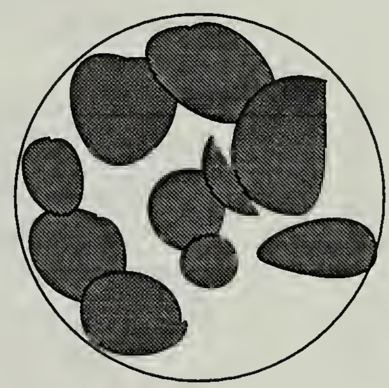
3% cover or
1-5% cover range
(use 3.0 midpoint value)



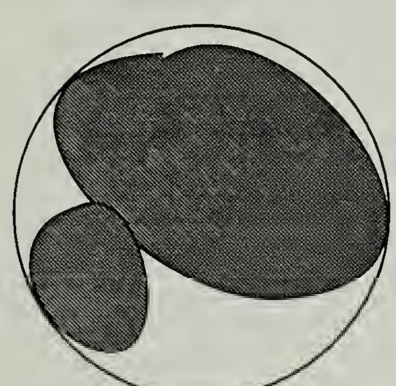
12% cover or
6-15% cover range
(use 10.5 midpoint value)



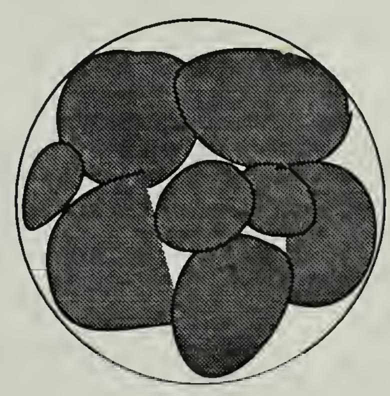
32% cover or
26-50% cover range
(use 38.0 midpoint value)



58% cover or
51-75% cover range
(use 63.0 midpoint value)



68% cover or
51-75% cover range
(use 63.0 midpoint value)



83% cover or
76-95% cover range
(use 85.5 midpoint value)

Vegetative Community Analysis: The Dominance Test

DEP recommends the use of the dominance test to verify or delineate BVW boundaries. The dominance test should be used to determine whether wetland indicator plants make up 50 percent or more of the vegetative community. The dominance test is a sampling technique that uses dominant plants within an observation plot to determine if the plot is a wetland or an upland. The test uses only the dominant plants in an observation plot since the dominant plants directly influence the composition of the remainder of the vegetation. However, the dominance test can be used to characterize the entire plant community in an observation plot. By identifying the dominant plants and whether they are wetland indicator plants, the vegetative community within an observation plot can be determined to be wetland or upland. If the number of wetland indicator plants is equal to or greater than the number of non-wetland indicator plants, the observation plot is in a wetland plant community.

The dominance test determines a plant species' dominance by evaluating percent cover. Information on percent cover is recorded for all plant species in each vegetative layer (ground cover, shrub, sapling, climbing woody vine, tree) present in the observation plot, but only for those layers with total percent cover greater than 5 percent. Basal area may be used instead of percent cover for identifying dominant plants in the tree layer (see Appendix B). Once dominant plants have been identified in each layer, they can be combined for purposes of the dominance test even if basal area is used for trees and percent cover is used for the other layers (see Example #1 in Appendix C). Dominant plants within each layer are recorded and classified as being either wetland indicator plants or non-wetland indicator plants.

The dominance test is less rigorous than other sampling techniques and can be performed fairly rapidly with practice. It is a method that generally yields good results. Conservation commissioners can apply the dominance test as a quick check in the field by visually identifying dominant plants in an area (without detailed estimates or measurements) and then determining whether 50 percent or more of the dominant plants are wetland indicator plants.

Other methods of vegetative community analysis are available and may be appropriate for use where site conditions are atypical or when rigorous documentation is required. In situations where reliance on dominant species would not adequately characterize the vegetation of an area, or where the dominance test yields inconclusive results, use of a more rigorous analysis may be advisable. At the discretion of the conservation commission or DEP, other methods may be used instead of the dominance test. Applicants who use methods other than the one recommended by DEP should provide a written explanation for using an alternative method and a description of how the methodology is used.

The Dominance Test Procedure (with examples)

1. **Evaluate percent cover:** For each observation plot do the following (basal area also may be used for the tree layer):

    a. Determine how many of the vegetative layers (ground cover, shrub, sapling, climbing woody vine, tree) have a total percent cover of 5 percent or more within the observation plot. Only those layers with a total percent cover of 5 percent or greater are to be used.

    b. For each vegetative layer, estimate or measure percent cover for each plant species in the layer. Any plant species with 1 percent cover or less should not be included. If you know a plant's name, list the name and its percent cover. If you do not recognize a plant or do not know a plant's name, call it a generic name (e.g. species x) and list its percent cover.

    Example:

Plant Species	Scientific name	Percent Cover
Ground cover:		
Canada mayflower	*Maianthemum canadense*	40
Cinnamon fern	*Osmunda cinnamomea*	30
Partridgeberry	*Mitchella repens*	15
Goldthread	*Coptis trifolia*	5
Princess pine	*Lycopodium obscurum*	5
Shrub:		
Mountain laurel	*Kalmia latifolia*	30
Winterberry	*Ilex verticillata*	25
Highbush blueberry	*Vaccinium corymbosum*	20
Northern arrowwood	*Viburnum recognitum*	5
Sapling:		
Ironwood	*Carpinus caroliniana*	30
Tree:		
Red maple	*Acer rubrum*	50
Northern red oak	*Quercus rubra*	40
Yellow birch	*Betula alleghaniensis*	15

2. **Determine percent dominance for plants in each layer:** For those layers within the observation plot with 5 percent cover or more, determine percent dominance for each plant species as follows:

    a. Add up percent cover for all plant species in the layer to determine the total percent cover for the layer.

    Example:

Ground cover:	40 + 30 + 15 + 5 + 5 = 95
Shrub:	30 + 25 + 20 + 5 = 80
Sapling:	30 = 30
Tree:	50 + 40 + 15 = 105

Dominance Procedure (continued)

b. Divide the percent cover for each plant species by the total percent cover for the layer, and multiply this by 100. This will yield percent dominance for each plant species in each layer.

Example:

	Percent Dominance
Ground cover:	
Canada mayflower: (40/95) x 100 =	42.1%
Cinnamon fern: (30/95) x 100 =	31.6%
Partridgefamily: (15/95) x 100 =	15.8%
Goldthread: (5/95) x 100 =	5.3%
Princess pine: (5/95) x 100 =	5.3%
Shrub:	
Mountain laurel: (30/80) x 100 =	37.5%
Winterberry: (25/80) x 100 =	31.3%
Highbush blueberry: (20/80) x 100 =	25.0%
Northern arrowwood: (5/80) x 100 =	6.2%
Sapling:	
Ironwood: (30/30) x 100 =	100%
Tree:	
Red maple: (50/105) x 100 =	47.6%
Northern red oak: (40/105) x 100 =	38.1%
Yellow birch: (15/105) x 100 =	14.3%

3. **Identify dominant plants:** Within the observation plot, identify the dominant plants in each layer:

a. Beginning with the most abundant species, list the plants in the layer until the cumulative total for percent dominance meets or exceeds 50 percent. In some cases, this will only be one species; in other cases, several species may be needed to meet the 50 percent threshold. These species are dominant plants for the layer.

b. Other species, not already listed in 3a., with a percent dominance of 20 percent or greater also are dominant plants and should be listed.

c. If additional species in the layer have the same percent dominance as any species already listed in 3a. and b., those species also are dominant plants and should be listed.

Example:
In the **ground cover** layer, Canada mayflower *(Maianthemum canadense)* (42.1%) does not break the 50% threshold, but the combined total for Canada mayflower and cinnamon fern *(Osmunda cinnamomea)* (73.7 %) does. Both of these species are considered dominant plants.

In the **shrub** layer, mountain laurel (*Kalmia latifolia)* and winterberry *(Ilex verticillata)* are considered dominant plants because their percent dominance taken together (68.8%) exceeds the 50% threshold. However, in this case, highbush blueberry *(Vaccinium corymbosum)* also is considered a dominant plant because its percent dominance (25%) exceeds the 20% threshold for this layer.

Dominance Procedure (continued)

Example continued:
In the **sapling** layer, ironwood (*Carpinus caroliniana)* is the only species present. The total percent cover for the layer (30%) exceeds 5%, therefore the layer is included. Ironwood is considered a dominant plant since its percent dominance (100%) exceeds the 50% threshold.

In the **tree** layer, the two most abundant species are considered dominant plants, red maple (*Acer rubrum*) and Northern red oak *(Quercus rubra*). The most abundant plant alone, red maple (47.6%), does not meet or exceed the 50% threshold, but the combined percent dominance of the two most abundant species does, red maple and Northern red oak (85.7%).

d. Those plants that meet a., b., and c. above are dominant plants for the layer. Identify the scientific name and indicator category for all dominant plants. The indicator category is taken from the National List of Plant Species That Occur in Wetlands: 1988 - Massachusetts.

Example:

Dominant Plants	**Scientific name**	**Wetland Indicator Category**
Ground cover:		
Canada mayflower	*Maianthemum canadense*	FAC-
Cinnamon fern	*Osmunda cinnamomea*	FACW
Shrub:		
Mountain laurel	*Kalmia latifolia*	FACU
Winterberry	*Ilex verticillata*	FACW+
Highbush blueberry	*Vaccinium corymbosum*	FACW-
Sapling:		
Ironwood	*Carpinus caroliniana*	FAC
Tree:		
Red maple	*Acer rubrum*	FAC
Northern red oak	*Quercus rubra*	FACU-

4. Determine whether the plant community is wetland or upland:

a. List the dominant plants (from 3a., 3b., and 3c. above) for all layers being evaluated. A given species may appear more than once on this list, if it is a dominant plant in more than one layer.

Example:

Dominant Plants	**Layer**	**Indicator Category**
Canada mayflower (*Maianthemum canadense)*	ground cover	FAC-
Cinnamon fern (*Osmunda cinnamomea)*	ground cover	FACW
Mountain laurel (*Kalmia latifolia)*	shrub	FACU
Winterberry *(Ilex verticillata)*	shrub	FACW+
Highbush blueberry *(Vaccinium corymbosum)*	shrub	FACW-
Ironwood (*Carpinus caroliniana)*	sapling	FAC
Red maple (*Acer rubrum)*	tree	FAC
Northern red oak (*Quercus rubra)*	tree	FACU-

Dominance Procedure (continued)

b. Determine how many of the dominant plants are wetland indicator plants according to the wetlands protection regulations. (Wetland indicator plants = plant species listed in the Wetlands Protection Act (see Appendix A); plants in the genus *Sphagnum*; plants in the National List classified as OBL, FACW+, FACW, FACW-, FAC+, and FAC; or any plants demonstrating morphological or physiological adaptations to life in saturated or inundated conditions.)

Example:

Canada mayflower	*Maianthemum canadense*	FAC-	
Cinnamon fern	*Osmunda cinnamomea*	FACW	*
Mountain laurel	*Kalmia latifolia*	FACU	
Winterberry	*Ilex verticillata*	FACW+	*
Highbush blueberry	*Vaccinium corymbosum*	FACW-	*
Ironwood	*Carpinus caroliniana*	FAC	*
Red maple	*Acer rubrum*	FAC	*
Northern red oak	*Quercus rubra*	FACU-	

Wetland Indicator Plants (*)

c. Determine the total number of wetland indicator plants and the total number of non-wetland indicator plants.

Example:
Total number of wetland indicator plants (*) = 5
Total number of non-wetland indicator plants = 3

d. If the number of wetland indicator plants is equal to or greater than the number of non-wetland indicator plants, the wetland vegetation criterion has been met. If vegetation alone is presumed adequate for the delineation, the plot is in a BVW. If vegetation alone is not presumed adequate, or to overcome the presumption, other indicators of hydrology also should be used to delineate the BVW boundary (see Chapter Three).

Example:

The area used for this example has eight dominant plants. The total number of wetland indicator plants (5) is greater than the total number of non-wetland indicator plants (3), therefore, the wetland vegetation criterion has been met.

Summary

Additional examples of the dominance test are provided in Appendix C.

Evaluating vegetative communities is an important step toward locating a BVW boundary. In some cases, reliance on vegetation alone will yield an accurate BVW boundary. In other cases, hydrology and vegetation should both be used to locate the BVW line. Chapter Three provides information on when vegetation alone may be used and when hydrology should be used in addition to vegetation. Procedures for delineating BVW boundaries are described in Chapter Five.

The Dominance Test Procedure Summary

1. **Evaluate percent cover:** For each observation plot do the following (basal area may be used for the tree layer):
   a. Determine how many of the vegetative layers (ground cover, shrub, sapling, climbing woody vine, tree) have a total percent cover of 5 percent or more within the observation plot. Only those layers with a total percent cover of 5 percent or greater are to be used.

   b. For each vegetative layer, estimate or measure percent cover for each plant species in the layer. Any plant species with 1 percent cover or less should not be included. If you know a plant species' name, list the name and its percent cover. If you do not recognize a plant or do not know a plant's name, call it a generic name (e.g. species x) and list its percent cover.

2. **Determine percent dominance for plants in each layer:** For those layers within the observation plot with 5 percent cover or more, determine percent dominance for each plant species as follows:
   a. Add up percent cover for all plant species in the layer to determine the total percent cover for the layer.

   b. Divide the percent cover for each plant species by the total percent cover for the layer, and multiply this by 100. This will yield percent dominance for each plant species in each layer.

3. **Identify dominant plants:** Within the observation plot, identify the dominant plants in each layer:
   a. Beginning with the most abundant species, list the plants in the layer until the cumulative total for percent dominance meets or exceeds 50 percent. In some cases, this will only be one species; in other cases, several species may be needed to meet the 50 percent threshold. These species are dominant plants for the layer.

   b. Other species, not already listed in 3a., with a percent dominance of 20 percent or greater also are dominant plants and should be listed.

   c. If additional species in the layer have the same percent dominance as any species already listed in 3a. and b., those species also are dominant plants and should be listed.

   d. Those plants that meet a., b., and c. above are dominant plants for the layer. Identify the scientific name and indicator category for all dominant plants. The indicator category is taken from the <u>National List of Plant Species That Occur in Wetlands: 1988 - Massachusetts</u>.

4. **Determine whether the plant community is wetland or upland:**
   a. List the dominant plants (from 3a., b., and c. above) for all layers being evaluated. A given species may appear more than once on this list, if it is a dominant plant in more than one layer.

   b. Determine how many of the dominant plants are wetland indicator plants according to the wetlands protection regulations. (Wetland indicator plants = plant species listed in the Wetlands Protection Act (see Appendix A); plants in the genus *Sphagnum*; plants in the National List classified as OBL, FACW+, FACW, FACW-, FAC+, and FAC; or any plants demonstrating morphological or physiological adaptations to life in saturated or inundated conditions.)

   c. Determine total number of wetland indicator plants and total number of non-wetland indicator plants.

   d. If the number of wetland indicator plants is equal to or greater than the number of non-wetland indicator plants, the wetland vegetation criterion has been met. If vegetation alone is presumed adequate for the delineation, the plot is in a BVW. If vegetation alone is not presumed adequate or to overcome the presumption, other indicators of hydrology also should be used to delineate the BVW boundary (see Chapter Three).

CHAPTER THREE
Delineation Criteria

The Wetlands Protection Act defines a wetland as an area with a significant portion of wetland indicator plants and subject to certain hydrologic conditions (surface water or groundwater). Wetland indicator plants are often accurate indicators of wetland hydrology. Under certain site conditions, such as where there is an abrupt change in topography, the use of plants alone generally will yield an accurate BVW boundary. In other cases, such as when the transition zone is gradual, other indicators of wetland hydrology, together with vegetation, may be used to determine the BVW boundary. The wetlands protection regulations describe those situations where vegetation alone is presumed to be sufficient for delineating BVW boundaries, and when vegetation and hydrology should both be used.

When vegetation alone may be used for delineating BVWs (and hydrology is presumed to be present)

The wetlands protection regulations presume that the delineation of BVWs based on vegetation alone is accurate under any one of the following circumstances:

1. **All dominant species in the vegetative community have an indicator category of OBL, FACW+, FACW or FACW- and the slope is distinct or abrupt between the upland plant community and the wetland plant community.**

2. **The area where the work will occur is clearly limited to the buffer zone.**

3. **The issuing authority (conservation commission or DEP) determines that sole reliance on wetland indicator plants will yield an accurate delineation.** (Note: if information on indicators of hydrology is submitted, it must be evaluated by the issuing authority.)

Vegetation may be used as the sole criteria for delineating BVWs in the vast majority of cases. Where activities are proposed in areas that are clearly outside wetland resource areas (in buffer zones), BVW delineations based on vegetation alone are generally sufficient. In other cases, such as where BVWs have abrupt or distinct boundaries or where the conservation commission or DEP determines that reliance on vegetation alone is sufficient for determining the BVW boundary, information about soils or other indicators of hydrology do not have to be submitted. However, when information on indicators of wetland hydrology is submitted (such as long-term hydrologic data or the presence or absence of hydric soils), it must be evaluated for accuracy and used by the issuing authority to establish the BVW boundary.

In determining whether reliance on vegetation alone will yield an accurate delineation, the following factors should be considered:

- Facultative plant species commonly occur in uplands as well as in wetlands (e.g. sweet pepperbush (*Clethra alnifolia*), cottonwood (*Populus deltoides*), sheep laurel (*Kalmia angustifolia*), New York fern (*Thelypteris noveboracensis*)).

- Several plants with an indicator category of FAC- or drier are not uncommon in wetlands, such as white pine (*Pinus strobus*), pitch pine (*Pinus rigida*), and American beech (*Fagus grandifolia*).

- Extended droughts can produce changes in vegetation in herbaceous plant communities.

- Many species in the ground cover layer may not be detectable or identifiable in winter or early spring.

- In areas where the vegetation has been altered (wetlands violations, lawns, golf courses, cultivated areas), hydric soils and other indicators of hydrology are particularly useful for identifying and delineating BVWs.

In these situations, the issuing authority has the discretion to request additional information to document the presence of wetland hydrology, such as whether hydric soils are present.

When vegetation and hydrology should be used for delineating BVWs

When the BVW boundary based on vegetation alone is not presumed accurate, or to overcome the presumption, vegetation and hydrology should both be used to establish the BVW boundary. This generally will occur when:

1. **the wetland area is not dominated by plants with an indicator category of FACW- or wetter,**

2. **the BVW boundary is not abrupt or discrete, or**

3. **the plant community has been altered.**

In these cases, the applicant should submit information on vegetation and other indicators of hydrology (such as hydric soils) to document the presence of wetland hydrology. The issuing authority should review all the information, evaluate its accuracy, and use it to establish or verify the BVW boundary.

CHAPTER FOUR
Indicators of Wetland Hydrology

As discussed in Chapter One, hydrology is the driving force behind wetland systems. There are a number of ways to determine whether wetland hydrology is present at a site. Wetland plants (discussed in Chapter Two) generally are very reliable indicators of long-term hydrology. However, the wetlands regulations specify that at certain sites, additional indicators of hydrology may be used to determine a BVW boundary. Wetland soils (hydric soils) also are considered very reliable indicators of long-term wetland hydrology. Other indicators, such as water marks on trees and water-stained leaves, may be used to determine the presence of wetland hydrology. However, due to the seasonal or temporal nature of these features, they should be carefully considered with other indicators.

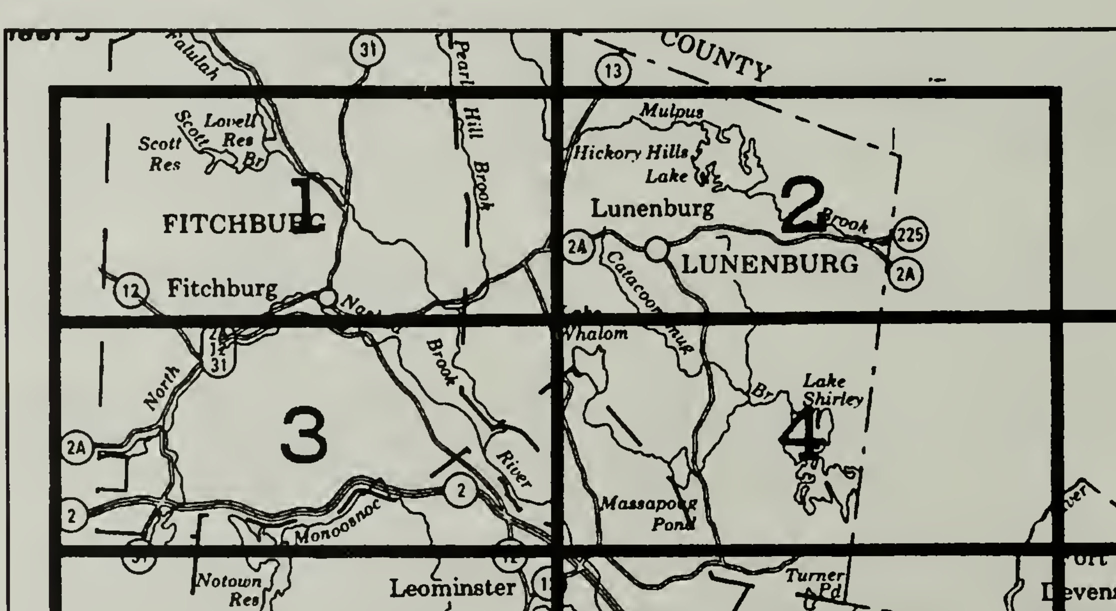
Soils Introduction

Most people come into contact with soils through routine activities such as gardening and general yard work. In these situations, soils and their important influence on vegetation and the landscape are often overlooked. The following is a description and discussion of the thin layer of the earth's surface that is referred to as soil.

Soil is the unconsolidated material on the earth's surface that supports or is capable of supporting plants. It is an essential component of most ecosystems. Soils are mixtures of mineral components (sand, silt, clay, gravel), organic matter, air, and water. Characteristics of soil (pH, chemical composition, texture, depth, amount of organic matter) have a large influence on plant communities and on animals that live in the soil. However, most soil characteristics are not evident on the surface; you have to dig a hole to observe and evaluate them.

Soil Survey Maps

The U.S. Natural Resources Conservation Service (NRCS) - formerly called the Soil Conservation Service (SCS) - has mapped soils throughout Massachusetts and soil surveys are available for most areas in the state. (Soil surveys may be obtained from NRCS offices; see contact information in Appendix H.) Each soil survey has an index map that allows you to determine which soils map to use for a given area. (See sample below).



A section of an index map from the Worcester County Soil Survey. A portion of Map 4 is shown on page 23.

The soils map itself is an aerial photograph over which soil types have been delineated and labeled. Codes on the map can be used to identify soil type (see sample below) and descriptions of each soil type are included in the soil survey report. Soils are described in terms of their slope, texture (sand, silt, clay, gravel), color, horizonation, and drainage (see samples on page 24).

Soil surveys are important tools that can be used to familiarize yourself with an area before going out to the site. In addition, the soil survey maps show general locations of waterways, water bodies, and wetlands. Other features, such as certain roads and buildings, also may be shown. Reviewing the soil survey will give you an idea of the landscape features of the area and whether the area may contain wetlands.

Soil descriptions provide useful information about the drainage characteristics of soils, with classifications ranging from excessively drained to very poorly drained. Wetland soils are typically classified as poorly drained or very poorly drained. Additional information about seasonally high water tables and the frequency and duration of flooding also are provided. Information on the suitability of the soil to support various activities such as agriculture, sanitary facilities, and building site development is included.

A portion of soils map # 4 from the Worcester County Soil Survey. Areas of Woodbridge (WrB) and Scarboro (Sc) soils can be found in the circled areas at center and right, respectively. Descriptions of these two types of soil from the soil survey report are shown on page 24.

The soil descriptions identify smaller areas within the area of mapped soil type that may be found within the soil. These smaller areas, which are called inclusions, generally are less than three acres in size and are not shown on the soil survey map. They are, however, described in the third paragraph of each soil description. (Examples of these inclusions are found in the narrative samples highlighted below.) All of this information is helpful in preparing for the site investigation.

Sc---Scarboro mucky fine sandy loam. This soil is very deep, nearly level, and very poorly drained. It is in low-lying areas and depressions on outwash plains. The areas of this soil are irregular in shape. They range from 5 to 50 acres, but most are about 10 acres. Slopes range from 0 to 3 percent.

Typically, the surface layer is covered with about 8 inches of organic material. The surface layer is black mucky fine sandy loam about 6 inches thick. The substratum is grayish brown and extends to a depth of 60 inches or more. The upper part is loamy sand, the middle part is sand, and the lower part is gravelly sand.

Included with this soil in mapping are small areas, mainly less than 3 acres each, of Swansea and Walpole soils. Also included are poorly drained, sandy soils. Included areas make up about 20 percent of this unit.

The permeability of this Scarboro soil is rapid or very rapid throughout. Available water capacity is high. Reaction ranges from very strongly acid to moderately acid. The water table is between the surface and a depth of 1 foot during most of the year.

Most areas of this soil are covered with brush and trees.

Soil description for Scarboro soil. *This is a wetland (hydric) soil. Note in the description that it is very poorly drained, which is generally indicative of wetland soil. Note also the description of the soil color as grayish brown, which may indicate wetland soil.*

WrB---Woodbridge fine sandy loam, 3 to 8 percent slopes. This soil is very deep, gently sloping, and moderately well drained. It is on the tops of drumlins on glacial till uplands. The areas of this soil are irregularly shaped or rectangular. They range from 5 to 30 acres, but most are about 10 acres.

Typically, the surface layer is very dark grayish brown fine sandy loam about 9 inches thick. The subsoil is dark yellowish brown and light olive brown sandy loam about 13 inches thick. The substratum is very firm, grayish brown sandy loam to a depth of 60 inches or more.

Included with this soil in mapping are small areas, mainly less than 3 acres each, of Paxton and Ridgebury soils. Also included are areas of soils that are friable to a depth of 30 inches or more. Included areas make up about 15 percent of this unit.

The permeability of this Woodbridge soil is moderate in the subsoil and slow or very slow in the substratum. Available water capacity is moderate. Reaction ranges from very strongly acid to moderately acid throughout. The seasonal high water table is at a depth of 1 1/2 to 3 feet.

Soil description for Woodbridge soil. *This is an upland soil. Note in the description that it is moderately well-drained, which is generally indicative of upland soil. Note also the inclusion in the third paragraph which indicates smaller areas of Ridgebury soil, which is classified as a wetland (hydric) soil.*

Soil Profile

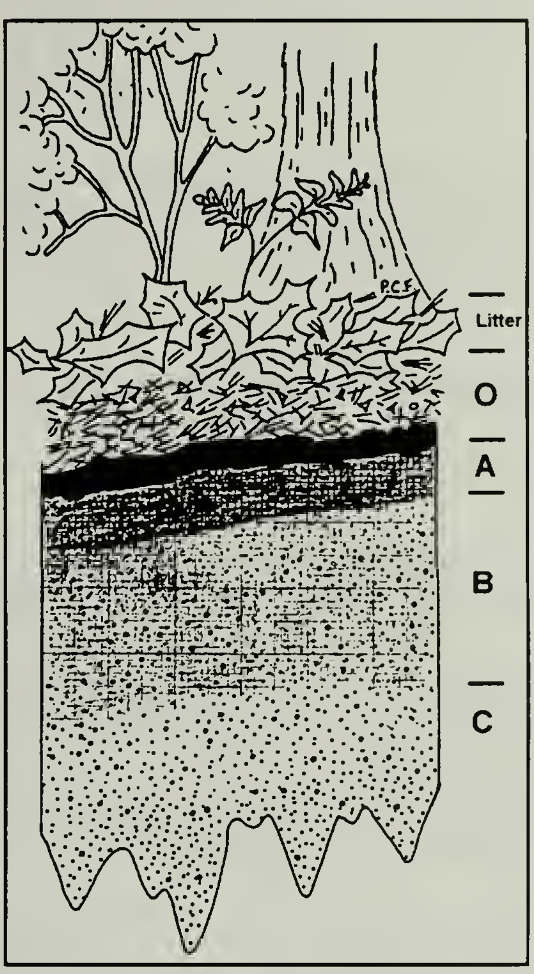
Descriptions of soils usually refer to soil horizons. Horizons are distinct layers of soil, generally parallel with the soil surface, having similar properties such as color and texture. Common soil horizons include the O, A, E, B, C, and R horizons. A vertical section of soil from the surface extending downward through its horizons is called the soil profile.

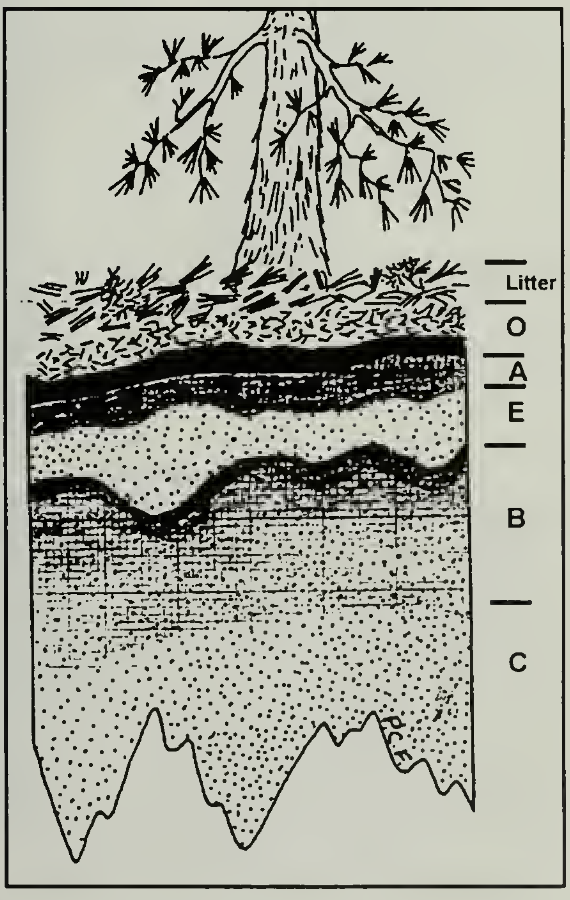
Many undisturbed soils have surface horizons primarily made up of partially to well decomposed organic matter. If such organic horizons exist, they are called **O-horizons**. Within a woodland area, there are typically several different O-horizons, each with varying degrees of decomposition. The uppermost part of the O-horizon often consists of matted leaves, pine needles, and twigs, underlain by other O-horizons of partially and well decomposed organic matter. Freshly fallen leaves and pine needles that can be easily brushed aside are called the litter layer. The litter layer is not considered part of the O-horizons.

The **A-horizon**, often called the topsoil, is typically found below the organic layer (if one exists) and consists of mineral soil mixed with decomposed organic matter. The presence of organic matter in the A-horizon darkens the soil and often masks other soil features, making it difficult to differentiate them. The topsoil usually ranges from 6 to 12 inches thick. Under natural conditions, the depth of the A-horizon is variable at any given site. In areas where the upper part of the soil has been mixed as a result of agricultural plowing, the A-horizon is typically a uniform thickness with a sharp, smooth lower boundary. In some areas, the leaching of iron and other metals may leave soils gray just below the A-horizon. Where this occurs, this gray layer is called the **E-horizon**.

Below the A-horizon, organic matter content in the soil is reduced and the soil colors and other features are more easily interpreted. Weathered (oxidized) soil underlying the A-horizon is the **B-horizon** and is often called the subsoil. Some wetlands lack a B-horizon because the processes of soil formation are strongly limited by wet conditions. Below the B-horizon is the **C-horizon**, which is made up of unweathered geologic material. The **R-horizon** is a layer of hard, unbroken bedrock such as granite, basalt, or quartzite that occurs below all other horizons where present. Outcroppings of ledge above the surface of the ground are good indicators that bedrock is near the surface.

Soil Profile Illustrations



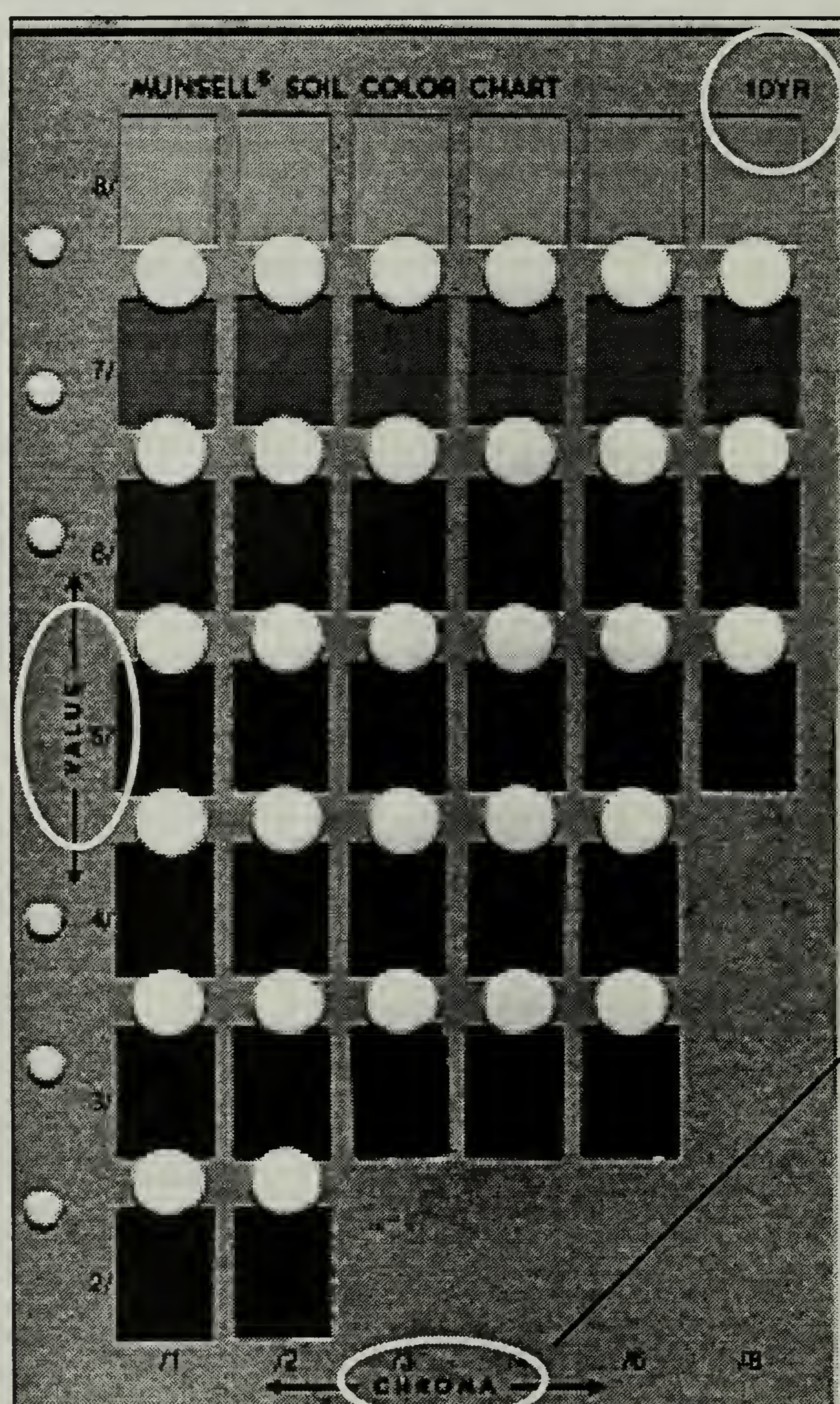


Soil illustrations by Peter C. Fletcher, U.S. Natural Resources Conservation Service

Soil Color

Soil color is evaluated with the aid of Munsell Soil Color Charts (see sample page below). Color chips are used to match soil color with respect to hue (spectral color), value (lightness or darkness), and chroma (color strength or purity). The predominant color of the soil is called the matrix color; other colors within the soil are called mottles. The chroma of the soil matrix and mottles is an important characteristic for identifying wetland (hydric) soils.

Each page of the Munsell charts represents a different hue. Hue is indicated in the top right corner of the page. Most soils in Massachusetts can be matched to colors on the 7.5YR (7.5 yellow-red), 10YR (10 yellow-red), 2.5Y (2.5 yellow) or 5Y (5 yellow) pages of the charts. Each page (hue) has rows and columns of color chips representing different values (along the vertical axis) and chromas (along the horizontal axis). Soils are matched to the appropriate color chips by holding a piece of the soil behind holes in the chart and comparing colors. Color information is recorded: hue value/chroma (i.e., 10YR 5/2). The appropriate color name can be read on the facing page. There also are special pages for "gleyed" soils, which are very gray wetland soils.



*— **Hue** is indicated in the top right corner of each page. This page is 10YR.*

*Note the **values** (lightness or darkness) along the vertical axis.*

*Note the **chromas** (color strength or purity) along the horizontal axis.*

A page (10YR) from the Munsell Soil Color Charts. Color information is recorded as: 10YR 5/2 (hue) (value/chroma)

Hydric Soil

Soils found in wetlands are called hydric soils. Hydric soil is a relatively new term developed in the mid-1970s by wetland scientists working for the U.S. Fish and Wildlife Service with help from the Natural Resources Conservation Service. Hydric soil is defined as "a soil that is saturated, ponded, or flooded long enough during the growing season to cause anaerobic conditions in the upper part." Anaerobic conditions produce physical and chemical changes in the soil that are readily observable and serve as hydric soil indicators. Hydric soil indicators generally require many years to develop. As a result, soils are good indicators of the long-term hydrology of an area. Once developed, the physical indicators of saturated conditions persist even after the hydrology of an area has been altered. Hydric soil indicators are especially useful for delineating wetlands where the vegetation has been altered.

The NRCS has developed local lists (by county) of soil series that are considered hydric. It is important to note, however, that boundaries shown on soil survey maps are approximate. A site visit is essential to verify the information contained in the soil survey and to accurately delineate the BVW boundary.

Hydric soils can be divided into two groups based on characteristics that can be observed in the field using soil test holes. These are organic soils and hydric mineral soils.

Organic Soils

Organic soils are made up of partially to well decomposed plant material mixed with mineral elements. Generally, organic matter makes up 20-30 percent or more of the soil (depending on the amount of clay present). Organic soils form in certain wetlands (especially bogs, fens, and marshes) where anaerobic conditions slow the rate of decomposition and organic matter accumulates over time. They generally can be recognized in the field by their dark color, slippery or fibrous texture, and tendency to stain fingers when handled. Organic soils also are less resistant than mineral soils to probing with a knife or shovel. When walking across these soil areas, they often feel spongy underfoot.

Soils with at least 16 inches of organic material measured from the ground surface are hydric soils and are referred to as **histosols**. Histosols are classified as fibrists (peats), saprists (mucks), and hemists (mucky-peats and peaty-mucks). Soils with 8 to 16 inches of organic material measured from the ground surface also are hydric soils and are referred to as having a **histic epipedon** (thick organic surface layer). Histosols and soils with a histic epipedon are always hydric soils.

Hydric Mineral Soils

Mineral soils contain less than 20-30 percent organic matter and are made up primarily of sand, silt, and clay, with varying amounts of gravel, cobbles, and stones. Hydric mineral soils are typically characterized by low-chroma colors (0-2 on the Munsell Soil Color Charts) that result from gleization.

Gleization occurs when iron is reduced and becomes mobile due to anaerobic soil conditions. Chemical change resulting from the presence of oxygen is called oxidation. Many of the bright colors (brown, orange, and red) found in upland soils are the result of oxidized iron on the surface of soil grains. Chemical change that results from the absence of oxygen (anaerobic conditions) is called reduction. When soils are saturated or inundated long enough to produce anaerobic conditions, iron is reduced. Unlike oxidized iron, reduced iron is soluble in water and may move a short distance, or is sometimes entirely leached out of saturated sandy soils. This leaching process often creates soils that are dull-colored (low-chroma) or gray. These are hydric soils and are known as **gleyed soils**. They are typically neutral gray or occasionally bluish, or greenish-gray in color. The Munsell Soil Color Charts have special pages for gleyed soils.

Some mineral soils may not readily show hydric soil characteristics due to texture (sandy soils), high iron contents (red soils), or floodplain dynamics. (See the section on Soils that are Difficult to Analyze.)

Under conditions of prolonged saturation, sulfur may become reduced and is converted by bacteria into sulfur gas (hydrogen sulfide), giving some wetland soils a smell like "rotten eggs."

In areas where the water table fluctuates, leading to alternating periods of oxidation and reduction, iron often accumulates in brightly colored mottles or concretions (hard nodules). In areas of fluctuating water tables, oxidized iron also may accumulate along the living roots of plants, forming oxidized rhizospheres.

Oxidized Rhizospheres

Roots and other underground plant structures growing in saturated soil conditions may produce brightly colored areas in the soil called oxidized rhizospheres. Roots need oxygen in order to survive and function. Under anaerobic soil conditions, oxygen moves to the roots from other parts of the plant. Leakage of this oxygen results in the oxidation of iron in the soil surrounding the roots. In areas of fluctuating water tables, this process creates brightly colored root channels (oxidized rhizospheres) in the soil. Oxidized rhizospheres are often evident within the topsoil and can be especially useful for confirming the presence of saturated soil conditions just below the ground's surface.

Hydric Soil Indicators

Most hydric soils have a soil horizon with a chroma of 0, 1, or 2 below the A-horizon. These are referred to as low-chroma colors. (Reminder: the Munsell Soil Color Charts are used to determine soil colors.) Generally, when evaluating mineral soils for low-chroma colors or other evidence of saturation, look for indicators directly below the A-horizon and within the top 12 inches of the soil surface. In areas where the O-horizon is less than 8 inches thick, soil depths are measured from the bottom of the O-horizon. When the O-horizon is 8 inches or greater (for histosols and soils with histic epipedons), such depths are measured from the soil surface. The soil surface is the top of the mineral soil; or, for soils with an O-horizon, the soil surface is measured from the top of the O-horizon. Fresh leaf or needle fall that has not undergone observable decomposition (the litter layer) is excluded from soil and may be separately described.

The following is a list of some hydric soil indicators - any of which can be used to identify the presence of wetland hydrology:

- Histosols (organic soils). Histosols are soils with at least 16 inches of organic material measured from the soil surface.

- Histic epipedons. These are soils with 8 to 16 inches of organic material measured from the soil surface.

- Sulfidic material. A strong "rotten egg" smell generally is noticed immediately after the soil test hole is dug.

- Gleyed soils. Soils that are predominantly neutral gray, or occasionally greenish or bluish gray in color within 12 inches from the bottom of the O-horizon. (The Munsell Soil Color Charts have special pages for gleyed soils.)

- Soils with a matrix chroma of 0 or 1 and values of 4 or higher within 12 inches from the bottom of the O-horizon.

- Within 12 inches from the bottom of the O-horizon, soils with a chroma of 2 or less and values of 4 or higher in the matrix, and mottles with a chroma of 3 or higher.

- Within 12 inches from the bottom of the O-horizon, soils with a matrix chroma of 3 and values of 4 or higher, with 10 percent or more low-chroma mottles, as well as indicators of saturation (i.e., mottles, oxidized rhizospheres, concretions, nodules) within 6 inches of the soil surface.

Soils that are Difficult to Analyze

In most cases, the hydric soil indicators previously listed are sufficient to identify wetland soils. However, certain soils are more difficult to assess, making it harder to determine whether hydric conditions exist. When these situations are encountered, a delineator or reviewer must evaluate all of the information that is available at the site and make a determination. At some sites, more weight should be given to other indicators of hydrology and vegetation if the soils information is inconclusive. In particularly difficult cases, consultation with the Natural Resources Conservation Service is recommended. The following is a list and discussion of soils that are difficult to analyze:

- **Sandy soils.** Soil colors often are not distinctive in most sandy soils. Instead, look for these indicators of hydric sandy soils:

    a) high organic content in the surface layer (typically darker colors with values less than 3 and chroma of 2 or less) with mottles or other indicators of saturation directly below;

    b) organic streaking directly below the A-horizon; or

    c) matrix chroma of 3 (from the Munsell Soil Color Charts) in the top 12 inches of soil measured from the bottom of the O-horizon, with distinct or prominent mottling.

  Indicators of hydric soils may be lacking altogether in the soil of newly formed sand bars and interdunal depressions.

- **Floodplain soils**. These soils usually are characterized by distinctly layered soil material. The layers form when new sediment is deposited during flood events. As a result of this pattern of deposition, hydric soil indicators may never form, or may be buried even though saturated or inundated conditions are present long enough to create wetland hydrology.

- **Soil from highly colored parent material.** Some soils derived from highly colored parent material have strong red, brown, or black colors. As a result, the gray colors indicative of hydric soils may not be obvious. Red soils generally are confined to certain areas within the Connecticut River Valley. Brown soils derived from Brimfield schists generally are found in and around the town of Brimfield. Black soils generally are confined to southeastern Massachusetts (principally Bristol County).

- **A-horizons that are thick and very dark.** A-horizons greater than or equal to 12 inches thick with values less than 3 and chroma of 2 or less are difficult to analyze because indicators of saturation are difficult to see. Therefore, look directly below the A-horizon for a matrix chroma of 1 or less and values of 4 or higher. If the matrix color directly below the thick and dark A-horizon is chroma 2 and value 4 or higher, other indicators of saturation need to be present in the soil directly below the A-horizon. In uncommon situations, it may be necessary to dig deeper to evaluate colors below the A-horizon.

- **Evergreen forest soils.** Sandy soils on Cape Cod and other areas dominated by evergreen trees may possess gray colored E-horizons just beneath the surface. These colors are not necessarily the result of saturation or inundation, but form as a result of the leaching of organic material and aluminum and iron oxides by organic acids. These soils are called **spodosols** and the gray layer that forms below the surface is known as the E-horizon. Organic material and aluminum and iron oxides are deposited in a layer below the E-horizon called the spodic horizon.

  Hydric indicators in spodosols include a combination of two or more of the following features, with one occurring within the upper 12 inches of the soil surface and others documented below the soil surface:

  a) a thick, black, sandy surface layer;

  b) organic streaking in the E-horizon;

  c) mottles within the E-horizon;

  d) oxidized rhizospheres within the A or E-horizon;

  e) iron concretions/nodules within the E-horizon or spodic horizon;

  f) a partially or wholly cemented spodic horizon usually within 18 inches of the surface measured from the bottom of the O-horizon; and

  g) mottling within the spodic horizon.

  Non-hydric spodosols can be recognized by brightly colored soil material below the E-horizon and without mottles or other indicators of saturation.

- **Areas where the hydrology has been recently altered.** In areas where the hydrology has been recently altered, hydric soil indicators may not accurately reflect the current hydrology of the site. Areas that have been recently flooded - or where the water table has risen due to flooding or some other change in hydrologic conditions - may not exhibit hydric soil characteristics. These areas may not have been saturated long enough to develop hydric characteristics. Conversely, areas that have been effectively drained and wetland hydrology is no longer present may still possess hydric soil indicators. Where there is evidence that the hydrology has been substantially altered at a site, careful evaluation of vegetation, soils, and other indicators of hydrology should be made before making a final delineation. Altered areas are particularly difficult to evaluate and require special attention.

Procedure for Evaluating Soils

The following is the recommended procedure for evaluating soils. While conducting these steps, record information on the DEP field data form (see Appendix G). See page 29 for a list of some hydric soil indicators.

1. **Consult topographic maps, soil survey maps, and other available information before heading out to the site.** Check to see whether soils in the area are on the list of hydric soils for the region. Familiarize yourself with the general soil characteristics (color, texture, drainage class) that you expect to encounter at the site.

2. **In the field, check the site for signs that the hydrology may have been altered (drainage ditches, drainage tiles, dams, etc.).**

3. **Evaluate the plant communities using the dominance test to identify wetland and upland communities (see procedure, pages 15-19).**

4. **Choose locations for soil test holes.** Soil test holes should be located in areas that are representative of each vegetative community (wetland and upland) within the observation plots. In areas where the topography is characterized by a combination of small mounds and depressions, several test holes may be needed to accurately characterize an area. Locate the test holes within whichever feature (mound or depression) is most abundant.

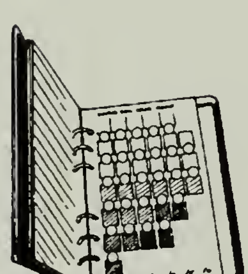
5. **Use a pointed shovel or spade to dig a hole approximately 1 foot by 1 foot to a depth of 20 inches.** Note: A shovel or spade should be used for digging soil test holes and sampling soils. Shovels or spades are recommended because augers often mix soil from different horizons and may disturb or obliterate soil characteristics. However, a soil auger may be used to quickly check soil conditions or to refine your boundary determination by checking between soil test holes.

6. **Note whether a strong odor of hydrogen sulfide ("rotten egg") is present.** A strong hydrogen sulfide odor identifies a hydric soil.

7. **After digging the test hole, use a knife to probe the upper part of the soil profile to determine the bottom of the litter layer** (where the knife does not go into the soil easily). This will indicate the soil surface, which generally is the level from which depths are measured.

8. **Use the shovel to remove a clean slice (cross section) of the soil profile approximately 6 inches wide and 20 inches deep.** It is easiest to evaluate the horizons by removing a clean slice from the hole and laying it on the ground.

9. **Feel or probe the soil to determine if there is an O-horizon (see organic soils, page 27).** If the O-horizon is at least 8 inches deep, then the soil is hydric and has a histic epipedon. When the O-horizon has a thickness greater than 16 inches, the soil is hydric and classified as a histosol.



10. **If the organic layer is less than 8 inches deep, use the Munsell Soil Color Charts to determine the color of the soil matrix and mottles (if present) within 20 inches of the mineral surface or just below the A-horizon.** To evaluate color, break off a representative chunk of moist soil material and compare it to the color chips on the Munsell charts. Use a spray bottle to moisten the chunk of soil, if the soil is not moist. Color comparisons should be made in good light, preferably direct sunlight (no sunglasses). Refer to the hydric soil indicators listed on page 29 to determine whether hydric indicators are present.

Procedure for Evaluating Soils (continued)

11. **Look for oxidized rhizospheres (root channels) and note their depth and abundance.** Oxidized rhizospheres within the A-horizon together with low-chroma colors right below the A-horizon are indicators of hydric soil.

12. **Observe to see if standing water gathers in the hole and note the depth.** Free water may take a while to gather in the soil test hole. You may want to leave the hole to continue your delineation steps and then go back later to see if water is present. Also note the depth at which water weeps from the sides of the test hole. Free water or weeping within 12 inches of the surface measured from the bottom of the O-horizon is a good indicator of wetland hydrology.

13. **Flag the location of the test hole(s) and note their location on the plans.**

Other Indicators of Hydrology

Vegetation and soils are considered the most reliable indicators of long-term wetland hydrology because they generally are observable throughout the year. However, other indicators also may be used to confirm the presence of wetland hydrology. These other indicators are presented in three categories: evidence of surface water, evidence of soil saturation, and morphological plant adaptations.

When delineating or reviewing a BVW boundary, note the presence of any of these other indicators and consider them in the evaluation. At many sites, these indicators can be used to refine the boundary delineation. When encountering difficult sites, it may be necessary to actively seek these other indicators to make the determination. Keep in mind, however, that some of these hydrologic indicators can be affected by recent heavy rain or seasons with above average amounts of precipitation. Conversely, these indicators may not be present during the entire year or may be absent during prolonged periods of drought.

Evidence of Surface Water

The following indicators may be used as evidence of surface water. Professional judgment should be used in deciding whether the presence of one or more of these indicators in an area is sufficient for establishing that wetland hydrology is present.

- **Hydrological records**, such as those from U.S. Geological Survey (USGS) stream gauging stations, U.S. Army Corps of Engineers data for major water bodies, state and local flood data, or NRCS state offices, can provide information on flood elevations, as well as the frequency and duration of flooding. Hydrological records that provide evidence of periods of continuous flooding from 7 to 21 days during the growing season are indicators of wetland hydrology.

- **Direct observation of inundation** during the growing season is an obvious indication of the presence of water. Observations over a period of days or weeks will provide a more reliable indication that the area has wetland hydrology. Recent weather conditions should be taken into consideration when using this indicator to establish the presence of wetland hydrology.

- **Water marks** on trees, boulders, bridge abutments, or other objects are good indicators of extended periods of inundation. Water marks can be stained or silt covered areas, or an abrupt change in plant or lichen growth that is present on several objects at a consistent elevation.

- **Water-stained leaves** on the ground are an indicator of inundation. Water-stained leaves are usually dull gray or black in color, and are flattened compared with those in surrounding (upland) areas.

- **Sediment deposits** on plants, leaves, or the ground are indicators of surface water, but generally do not provide much information about the timing or duration of inundation.

- **Drift lines** are accumulations of plant material or debris that are deposited, usually in lines parallel to the stream flow, during flood events. Drift deposits may be evident on the ground or occasionally in the branches of trees and shrubs. They are good indicators of surface water, but do not provide much information about the timing or duration of flooding.

- **Scoured areas** are good indicators of flowing water. These generally can be recognized by the relative absence of leaf litter and other debris on the ground, or where fine soils have been washed away, leaving gravel and cobble. Scoured areas are good indicators of flowing conditions, but do not provide much information about the timing or duration of flowing water.

- **Drainage patterns** left by flowing water indicate the presence of surface water. These can be water-induced patterns on the ground (washboard or braided patterns in the sediments), channels in the leaf litter, or where vegetation has been bent in one direction by the force of running water. Although these patterns do serve as indicators of surface water, they also may occur in upland areas.

- **Fingernail clam and aquatic snail shells** can occasionally be found in dry depressions and are good indicators of extended periods of inundation during the growing season. Be aware, however, that there are terrestrial snails in Massachusetts; their presence is not an indicator of wetland hydrology. Freshwater mussels, unlike fingernail clams, only occur in areas that are permanently flooded. The presence of mussel shells in areas other than aquatic habitats are not good indicators of wetland hydrology because they often are transported by predators.

- **Caddisfly cases** can occasionally be found in dry pools or intermittent streams. Caddisflies are insects that are aquatic as larvae and winged as adults. The larvae of many species construct tubelike cases around themselves, made of leaf fragments, twigs, pine needles, or sand. These cases often persist long after the water has dried up and serve as good indicators of extended periods of inundation during the growing season.

Evidence of Soil Saturation

The following indicators of hydrology may be used as evidence of soil saturation.

- **Free water in a soil test hole** indicates depth to the water table at that particular time. The depth at which water is observed weeping out of the soil into the hole also is an indicator of water table depth. Free water or weeping within 12 inches of the surface is a good indicator of wetland hydrology. However, recent weather conditions should be considered when using this indicator.

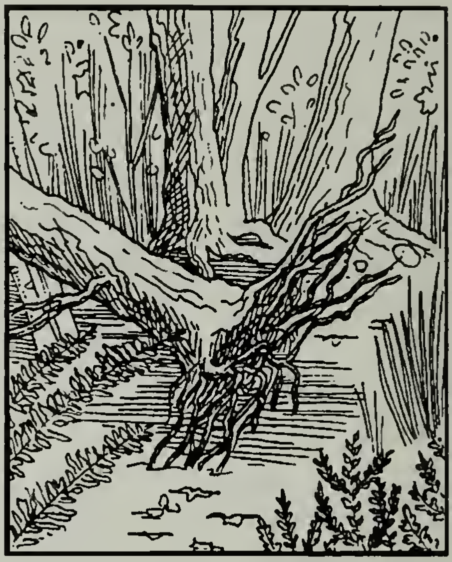
- **Saturated soil** usually occurs in areas above the water table due to capillary action within the soil. Saturated soils will yield water when squeezed. Saturated soil within 12 inches of the surface generally is a good indicator of wetland hydrology. However, recent weather conditions should be considered when using this indicator.

- **Oxidized rhizospheres** within the A-horizon together with low-chroma colors right below the A-horizon are good indicators of soil saturation during the growing season. Look for orange-stained channels along living plant roots in the soil (see page 28 for more information).

Morphological Plant Adaptations

Morphological adaptations are evident in the form or shape of a plant. Adaptations that result from inundation or saturation during the growing season are good indicators of wetland hydrology. In addition, plants demonstrating morphological adaptations are considered wetland indicator plants.

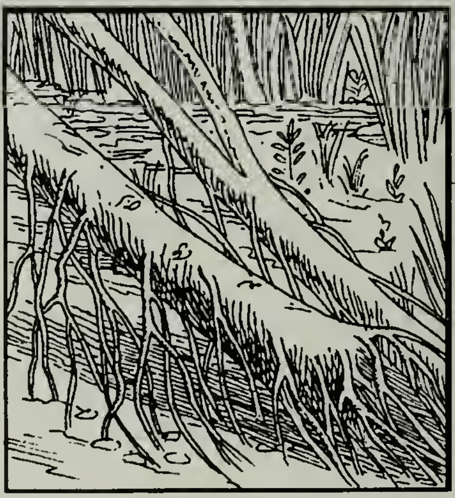
- **Shallow root systems** are probably the most useful adaptations that indicate wetland hydrology in areas near the wetland/upland boundary. This indicator can be just as useful with shrubs, saplings, and herbs as it is with trees. For instance, look for swollen trunks or roots along the surface of the ground as evidence of shallow root systems, or observe them directly on overturned trees. The key is to compare the root structures of like or similar species growing further upslope in an upland setting. Be aware that shallow root systems also form in upland areas where bedrock is close to the surface or in very stony soils. Use soil maps and topography to confirm that shallow root systems are the result of wetland hydrology and not stony soils or bedrock.



Shallow root systems

- **Buttressed or fluted trunks** are good indicators of hydrology that are often cited in publications about wetland delineation. In Massachusetts, however, trees and saplings rarely demonstrate the exaggerated, swollen bases typical of this adaptation. The moderately swollen bases typically found in Massachusetts usually indicate the presence of shallow root systems.

- **Adventitious roots** are roots that form on plant stems in positions where roots normally do not occur. This adaptation is most common on active floodplains and may be found on box elder (*Acer negundo*), sycamore (*Platanus occidentalis*), pin oak (*Quercus palustris*), green ash (*Fraxinus pennsylvanica*), cottonwood (*Populus deltoides*), and willows (*Salix spp.*).



Adventitious roots

- **Enlarged (hypertrophied) lenticels** on woody plants are indicators of inundated or saturated growing conditions. Lenticels are small pores, usually resembling dots or thin horizontal lines on the stems and twigs of woody plants. In response to saturated or inundated growing conditions, these pores can become swollen or enlarged. Enlarged lenticels can occasionally be found on red maple (*Acer rubrum*), silver maple (*Acer saccharinum*), and willows (*Salix spp.*).

- **Polymorphic leaves** form on certain plant species when portions of the plant are submerged while other portions extend above water. Plants like mermaidweed (*Proserpinaca palustris*), water parsnip (*Sium suave*), and arrowheads (*Sagittaria latifolia*) have different leaf forms depending on whether they grow above or below the water surface. Underwater leaves tend to be narrow or finely divided; leaves above the water surface tend to be broader and less divided. Where both forms occur on the same plant (polymorphic leaves), these are good evidence of surface water for an extended period during the growing season.

Plant with polymorphic leaves: mermaidweed (*Proserpinaca palustris*)

- **Air-filled tissue (aerenchyma)** forms in the roots and stems of many plants in response to prolonged periods of saturation or inundation. These specialized tissues help move oxygen from plant structures above water to those that are underwater or in saturated soil. Plants that possess these air-filled tissues are spongy when squeezed and the air cells are obvious when the plants are cut.

CHAPTER FIVE
Delineating and Reviewing BVW Boundaries

The delineation of a BVW boundary is critical because it ultimately influences both project design and the effectiveness of wetland protection efforts. In the Request for Determination of Applicability (RDA) process, a boundary delineation decision is effective for three years. In the Notice of Intent (NOI) process, a delineation is required to evaluate whether performance standards are being met. BVW boundaries may be appealed in either of these permitting processes. For these reasons, the accuracy of the delineation is important to successful wetlands protection.

Wetlands often occur as transitional areas between water bodies (and waterways) and uplands. Where the transition is gradual, it can be difficult to determine exactly where the BVW ends and the upland begins. The analyses of vegetation and hydrology are useful for determining whether a particular area is a BVW, but they will not yield a BVW delineation unless they are incorporated into procedures for locating the wetland/upland boundary.

The level of analysis used to delineate the BVW boundary should reflect the complexity of the site. Some wetlands have abrupt and obvious boundaries and rigorous analyses may not be necessary. Other areas may require detailed analysis of vegetation and hydrology in order to locate accurate boundaries. Moreover, the wetlands protection regulations establish criteria to determine when vegetation alone may be used to delineate the BVW boundary and when vegetation and hydrology should both be used (see Chapter Three).

Preparing for the Site Visit

Preparation before visiting the site is an important first step in the delineation or review process. Maps and other materials that can provide information about an area should be reviewed before you make a site visit. These data sources may include important information about the topography and soils of a site, water bodies, floodplains, and areas that may already have been mapped as wetlands. This preparation may improve your efficiency at the site by highlighting difficult areas where you can focus your attention, such as disturbed areas or gradual slopes. Also, be sure to secure permission from the landowner before entering private property.

Useful Data Sources

- **USGS topographic maps.** Topographic maps prepared by the U.S. Geological Survey are essential sources of information about site conditions. They provide information about the topography of a site and many wetlands and water bodies are shown as well. It is important to note, however, that some wetlands and intermittent streams are not shown on the maps. In many cases, topographic features on the map can be used to identify areas that may contain wetlands and streams not shown on the map.

- **NRCS soil survey maps and hydric soils lists.** Soil surveys published by the U.S. Natural Resources Conservation Service (formerly called the Soil Conservation Service) contain important information about site conditions. When using soil surveys, consult the list of hydric soils for the county. Both soil surveys and hydric soils lists are available from the NRCS.

- **DEP Wetlands Conservancy maps** (where available). DEP's Wetlands Conservancy Program is mapping wetlands statewide using aerial photography. These large-scale (1" = 417'), black-and-white maps (orthophotos) provide more detail than most other maps. See Appendix F for a list of maps that are available as of January 1, 1995, and how to receive updated information.

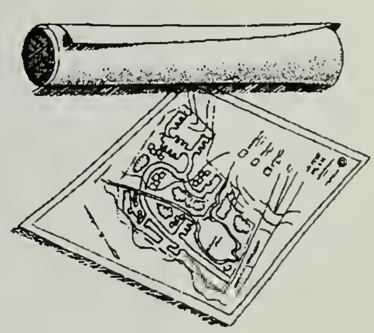
- **National Wetlands Inventory maps.** The U.S. Fish and Wildlife Service has mapped wetlands in Massachusetts as part of the National Wetlands Inventory (also known as NWI). NWI maps were developed from aerial photography taken in the 1970s and 1980s. They are available at the same scale and have the same quadrangle names as USGS topographic maps. It is important to note that many small wetlands are not shown on the maps, and that wetland boundaries on the maps are approximate. In cases where wetlands have been altered or destroyed, NWI maps can indicate the extent and location of previously existing BVWs for the purposes of enforcement.

- **Aerial photographs.** NWI and Wetlands Conservancy maps are based on aerial photography. Other aerial photography also may be available for some areas of the state. Infrared photography, taken in the spring before leaves are out, is useful for identifying wetlands. Aerial photographs can be used to document wetland violations; however, an experienced photointerpreter generally is required. See Appendix F for information about color infrared photography available from the Wetlands Conservancy Program.

- **Local wetlands and/or topographic maps (city or town).** In some towns and cities, local topographic or wetlands maps are available. These maps may provide details about a site not found on other maps.

- **Floodplain maps (National Flood Insurance Program).** Floodplain maps are available from the Federal Emergency Management Agency (FEMA). Developed for the National Flood Insurance Program, these maps provide useful information on flood prone areas and may indicate the presence of floodplain soils which may be difficult to analyze for hydric soil indicators. One hundred and 500-year floodplains are delineated for rivers and larger streams and some water bodies.

- **Site plans prepared by the applicant.** Before going out to a site, it is important to review site plans for the area. Applicants are required to submit information that describes conditions at a project site. This includes identification of all wetland resource areas. The BVW boundary should be marked in the field by numbered flags that correspond with the project plan.



- **Field data forms.** Field data forms prepared for the site should be reviewed in the office. The form should list the types of plant species found at various locations on the site. Reviewing the form prior to the site visit gives you an opportunity to check field guides for species with which you are not familiar, check the wetland indicator category of particular species, and consult related soils information, if necessary.

Tools to Bring to the Site:

- 100-foot measuring tape
- compass
- flagging tape
- site plans
- field data form
- permanent marking pen
- USFWS plant list
- plant identification guides
- Munsell Soil Color Charts
- shovel (spade)
- soil auger
- spray bottle
- knife
- hand lens
- calculator

Delineating BVW Boundaries

Bordering Vegetated Wetlands must border on a creek, river, stream (including an intermittent stream), pond, or lake. Bordering means that the wetland touches the bank of a water body, is contiguous with wetlands that touch the bank, or is connected via surface water (or culvert) to wetlands that touch the bank. Use topographic maps, site plans, or other sources of information to locate water bodies that may be associated with wetlands and then verify them in the field.

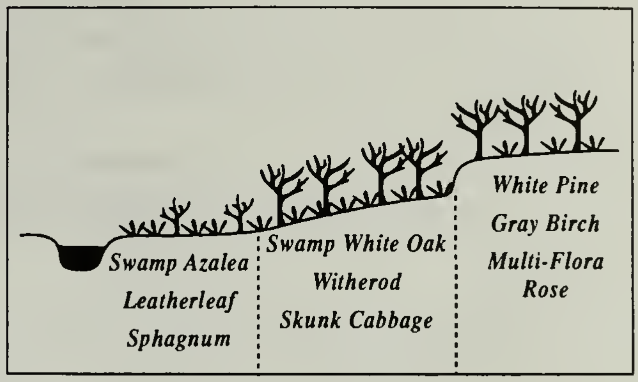
Once at the site, establish some general reference points such as property boundaries, stone walls, fences, or other field markers. This will help keep you oriented. Begin at the water body or an obvious wetland that borders the water body, and walk the site to determine whether it is an area where vegetation alone is adequate to delineate the boundary or whether vegetation and hydrology should both be used. (See Chapter Three for delineation criteria.)

Several methods of delineation are outlined in the following pages:

- Vegetation alone
- Vegetation along with indicators of hydrology
- Altered sites
- Winter delineations

Procedure where vegetation alone is presumed to yield an accurate boundary (hydrology presumed to be present)

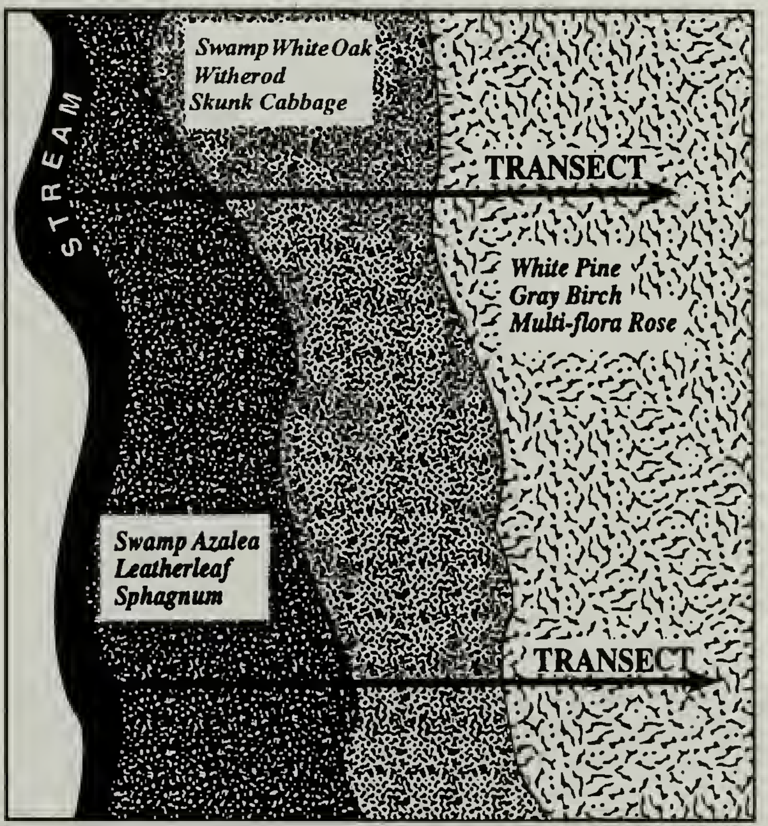
At sites where vegetation alone is presumed to yield an accurate boundary (and hydrology is presumed to be present), the following procedure should be used to delineate the BVW boundary. The diagrams that accompany this procedure are based on a site illustrated by the cross-section diagram at right. While conducting these steps, site information should be recorded on the DEP field data form (see Appendix G).



Vegetation alone is presumed to yield an accurate boundary at this site because the vegetation is FACW- or wetter and there is an abrupt slope between upland and wetland plant communities.

1. **Establish one or more transects from an obvious wetland to an obvious upland area.** A transect is an imaginary line that bisects a parcel of land. The transect(s) should generally run perpendicular to slope or topographic changes. The number of transects should reflect the complexity of the site and may range from one to several. Mark the beginning and end of each transect with a flag (use a different color than the one used for the boundary line or make a note on the flag).

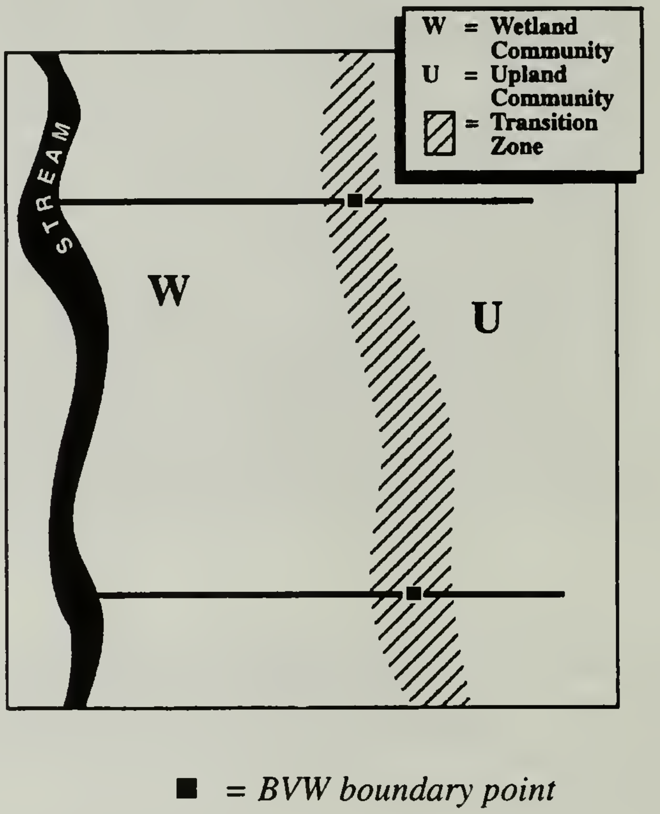
2. **Observe plant communities along the transect line(s).** Starting at the wetter end of the transect line, walk towards the upland. Observe obvious characteristics of the plant communities, such as types of plants and abundance.



1. Establish one or more transects.
2. Observe plant communities along transect(s).

3. **Assess each plant community to determine whether it is a wetland or upland vegetative community using visual assessment.** However, when assessing complicated sites, the dominance method should be used (see pages 15-19 for more information). If visual assessment is used to analyze the plant community, a brief explanation about how the conclusion was reached should be provided on the DEP field data form.

4. **Determine the BVW boundary point on each transect based on the assessment of vegetative characteristics.** Topographic changes also may be helpful in determining a boundary point.



3. Assess each plant community to determine whether it is wetland or upland.

4. Determine the BVW boundary point on each transect.

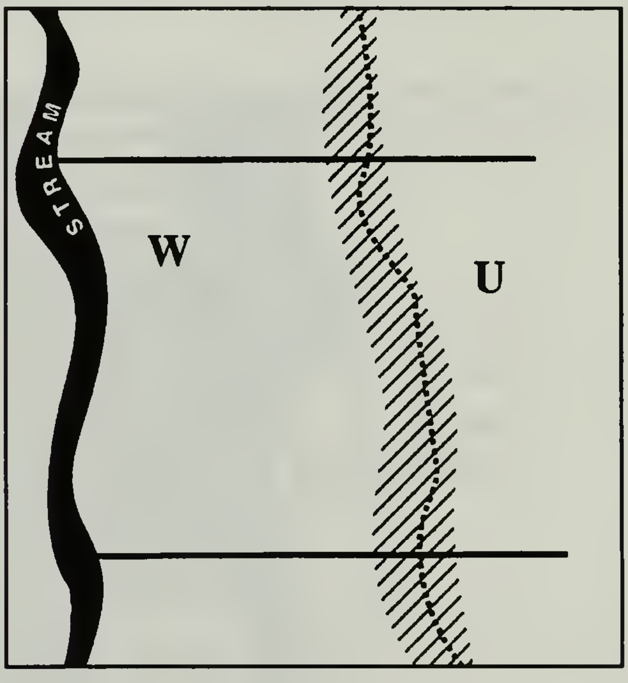
5. **Once all transects have been completed, use topographic and vegetative features to establish a line connecting the boundary points.** If only one transect is completed, use topographic and vegetative features to establish a boundary from that transect. Topography, vegetation, and other site features may signal changes from wetland to upland conditions. The following are examples of site conditions that may be useful to consider when determining the BVW boundary. These are just a few of the visual cues to look for at a site:

   A **change in topography**, such as a change in slope over a short distance, may indicate a boundary point.

   Variations in the herbaceous plant community, such as an obvious decrease in abundance of a specific wetland indicator plant like cinnamon fern (*Osmunda cinnamomea*, FACW), or an increase in abundance of a specific non-wetland plant such as princess pine (*Lycopodium obscurum*, FACU), may reflect a change in conditions at that location.

   Variations in the shrub plant community also may signal a boundary point, such as when a non-wetland shrub like mountain laurel (*Kalmia latifolia,* FACU) starts to become more abundant in an area with a decrease of a wetland shrub like highbush blueberry (*Vaccinium corymbosum,* FACW-).

   The presence or absence of **hydrologic indicators** also may be useful when establishing a boundary. One example would be shallow root systems indicated by wind-thrown trees and roots coming out of the ground.



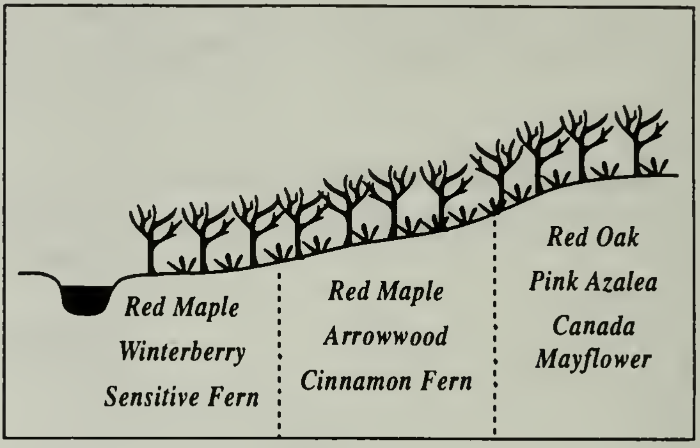
5. Use topographic and vegetative features to connect the boundary points.

6. **Use numbered flags (or stakes in disturbed areas or meadows) to mark the BVW boundary.** You should be able to see one flag while standing at another flag.

7. **Identify the location of BVW boundary flags or stakes on the site plans.**

Procedure for using vegetation and hydrology (soil as an indicator of hydrology) to determine the BVW boundary

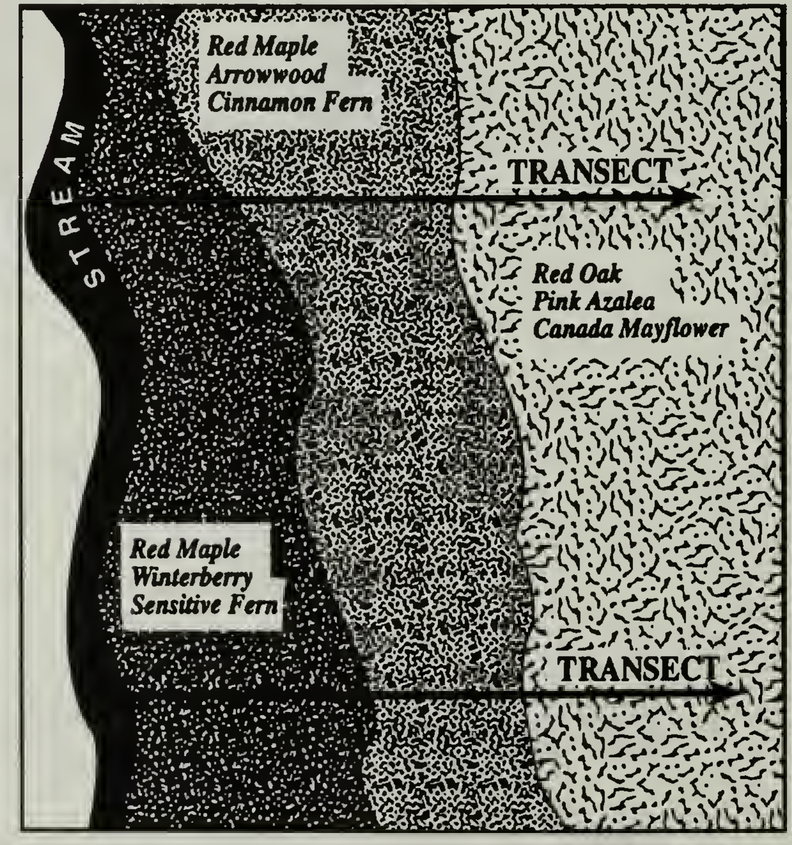
If using vegetation alone to delineate a BVW boundary is not appropriate, then the following procedure using vegetation and hydrology (e.g. hydric soils) should be used. The diagrams that accompany this procedure are based on a site illustrated by the cross-section diagram at right. While conducting these steps, site information should be recorded on the DEP field data form (see Appendix G).



Vegetation and hydrology should both be used to determine an accurate boundary at this site because the vegetation is not FACW- or wetter and there is a gradual slope between upland and wetland plant communities.

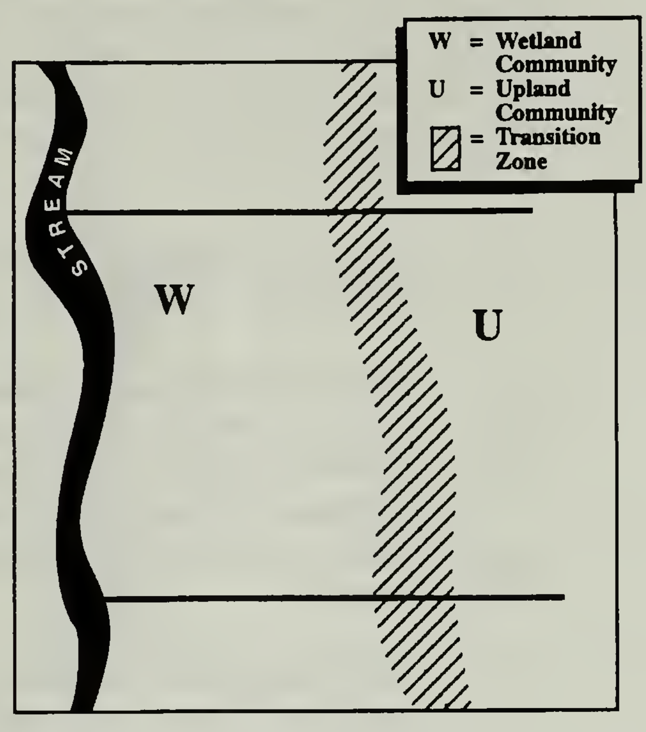
1. **Establish one or more transects from an obvious wetland to an obvious upland area.** A transect is an imaginary line that bisects a parcel of land. The transect(s) should generally run perpendicular to slope or topographic changes. The number of transects should reflect the complexity of the site and may range from one to several. Mark the beginning and end of each transect with a flag (use a different color than the one used for the boundary line or make a note on the flag).

2. **Observe plant communities along the transect line(s).** Starting at the wetter end of the transect line, walk towards the upland. Observe obvious characteristics of the plant communities, such as types of plants and abundance.



1. Establish one or more transects.
2. Observe plant communities along transect(s).

3. **Assess each plant community to determine whether it is a wetland or upland vegetative community using the dominance test.** (See pages 15-19 for details.)



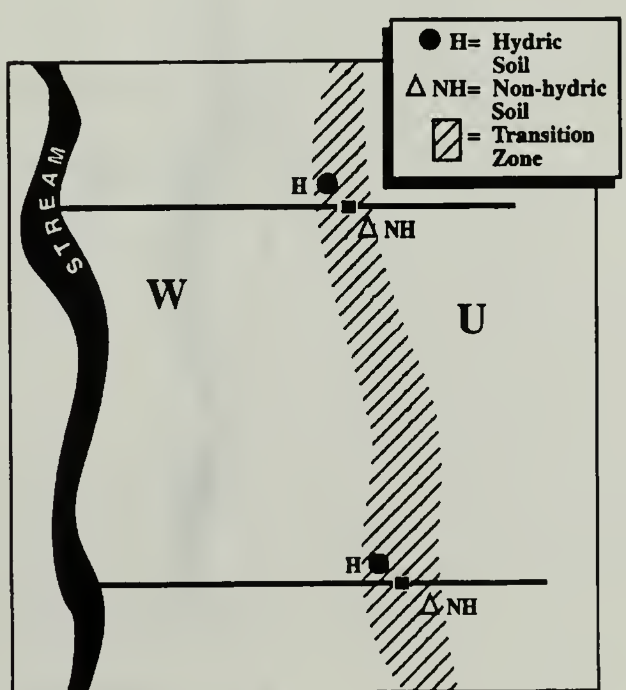
3. Assess each plant community to determine whether it is wetland or upland.

4. **Choose locations for soil test holes.** Soil test holes should be located in areas that represent each vegetative community (wetland and upland) within the observation plots used for vegetative analyses.

5. **Dig soil test holes and examine the soil characteristics to determine whether hydric soils are present.** (See pages 32-33 for soil evaluation procedure.)

6. **Use additional soil test holes, as needed, to determine the boundary between hydric and non-hydric soils.**

7. **Use vegetative and soil characteristics to determine the BVW boundary point on each transect.** Topographic changes also may be helpful in determining a boundary point.



5. Dig soil test holes and examine soil characteristics.

6. Use additional soil test holes, as needed, to determine the boundary between hydric and non-hydric soils.

7. Use vegetative and soil characteristics to determine the BVW boundary point on each transect.

■ = *BVW boundary point*

8. **Once all transects have been completed, use topographic and vegetative features and soil characteristics to establish a line connecting boundary points.** If only one transect is completed, use topographic and vegetative features and soil characteristics to establish a boundary from that transect. Topography, vegetation, and other site features may signal changes from wetland to upland conditions. The following are examples of site conditions that may be useful to consider when determining the BVW boundary. These are just a few of the visual cues to look for at a site:

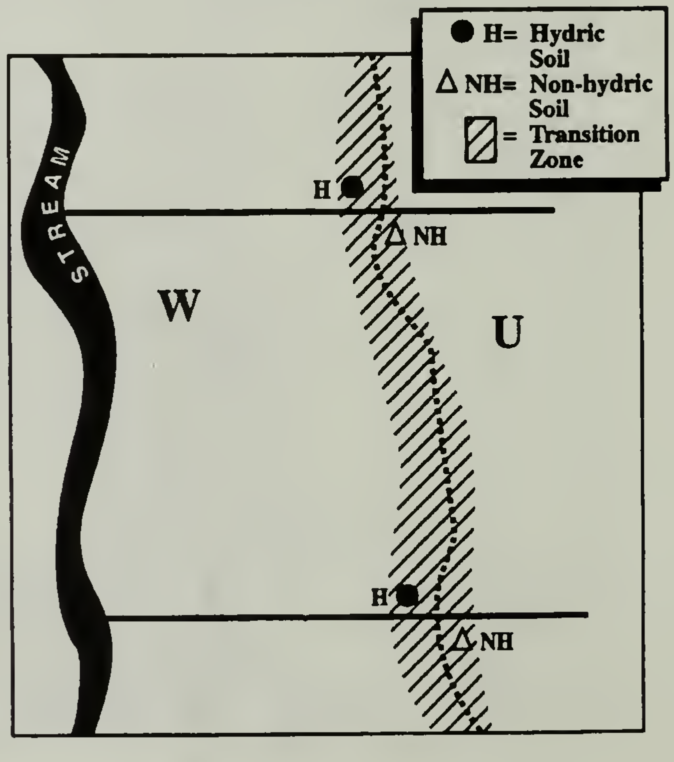
    A **change in topography**, such as a change in slope over a short distance, may indicate a boundary point.

    Variations in the herbaceous plant community, such as an obvious decrease in abundance of a specific wetland indicator plant like cinnamon fern (*Osmunda cinnamomea*, FACW), or an increase in abundance of a specific non-wetland plant like princess pine (*Lycopodium obscurum*, FACU), may reflect a change in conditions at that location.

    Variations in the shrub plant community also may signal a boundary point, such as when a non-wetland shrub like mountain laurel (*Kalmia latifolia,* FACU) starts to become more abundant in an area with a decrease of wetland shrub like highbush blueberry (*Vaccinium corymbosum,* FACW-).

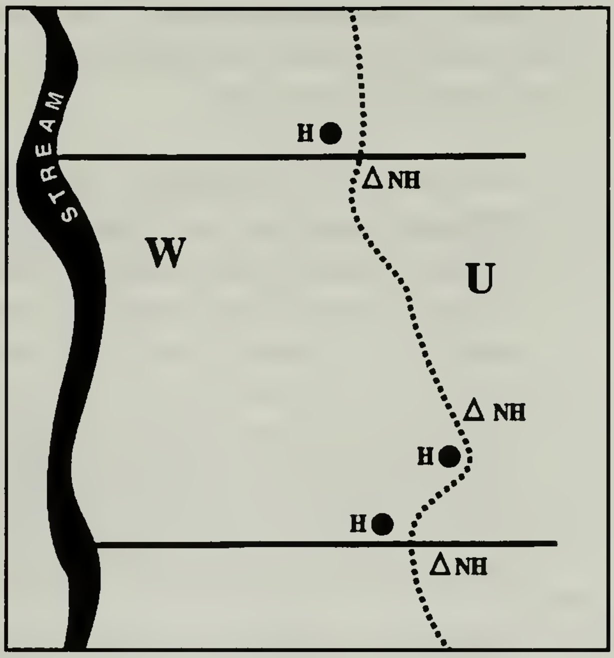
    Soil characteristics also may be used to locate the BVW boundary between transect points. Use a soil auger or spade to check soil characteristics and identify hydric and non-hydric soils to establish the boundary.

    The presence or absence of **other hydrologic indicators** also may be useful when establishing a boundary. One example would be shallow root systems indicated by wind-thrown trees and roots coming out of the ground.



8. Use topographic and vegetative features and soil characteristics to connect boundary points.

9. **At complex sites, use periodic soil test holes, with visual assessment of vegetation, to verify or adjust the BVW boundary.**



9. Use periodic soil test holes to verify or adjust the BVW boundary.

10. **Use numbered flags (or stakes in altered areas or meadows) to mark the BVW boundary and the location of soil test holes.** You should be able to see one flag while standing at another flag.

11. **Identify the location of BVW boundary flags or stakes and soil test holes on the site plans.**

Delineating BVWs where hydrology or vegetation has been altered

In areas where either hydrology or vegetation has been altered, additional investigation of site conditions will be needed to locate the BVW boundary. The procedure is basically the same as that previously outlined for using vegetation and soils to determine the BVW boundary. However, site conditions may require modifications that emphasize some indicators over others.

- In areas where hydrology has been recently altered, creating flooded conditions, hydric soils may not have formed. As a result, indicators of hydric soils may not be present even if wetland hydrology exists. In these areas, use vegetation and indicators of hydrology other than soils (e.g. hydrological records, water marks, water-stained leaves) to delineate the BVW boundary.

- Areas that have been recently drained will usually possess hydric soil indicators but lack other indicators of hydrology. Wetland plants may be present or absent depending on how recently and how extensively the hydrology has been altered. Hydric soils are often the best indicators for delineating recently drained wetlands.

- Areas where vegetation has been altered or removed - such as golf courses, lawns, and agricultural fields - require the use of soils and other indicators of hydrology to delineate BVW boundaries. In some cases, such as where vegetation has been cut or removed (e.g. ongoing forestry activity), remnant vegetation should be considered, but other indicators of hydrology also should be used to establish the BVW boundary.

- Areas where fill has been placed in wetlands require the analysis of soils directly beneath the fill. A hole must be dug through the fill until the original soil is exposed. Look for evidence of a buried surface horizon and evidence of normal horizonation (topsoil and subsoil layers). Soil surveys may be useful as a reference for distinguishing between the original soil and fill material. Once you have dug through the fill, analyze the original soils and determine whether they are hydric soils or not. Look for evidence of soil saturation (see page 35). If the fill is recent, there also may be identifiable plant parts beneath the fill that can be used to help delineate the BVW boundary.

- Areas where soil and vegetation have been removed often are the most difficult sites to evaluate. In these cases, historical records, such as NWI maps and aerial photographs, and visual assessments of adjacent sites may be useful in establishing the BVW boundary.

Winter Delineations

Delineating or verifying BVW boundaries during the winter months, especially with deep snow cover or frozen soil conditions, is difficult and under some extreme circumstances virtually impossible. Vegetation and other indicators of hydrology that are used to determine BVW boundaries are not readily observable or may be misleading during these times.

Fertile frond of the sensitive fern *(Onoclea sensibilis)*

Herbaceous vegetation or remnant vegetation (nuts, fruits, leaves) may be present but not visible if covered with snow. An example is the fertile frond of the sensitive fern (*Onoclea sensibilis*), which is persistent throughout the year, but may be hidden by deep snow.

Indicators of hydrology may be misleading or covered with snow. An example would be pockets or channels of ice on the ground surface. This condition may appear to indicate the presence of wetland hydrology, but also may be due to a number of different factors, such as snow melt that quickly freezes or a quick temperature drop after a brief rain that occurred with frozen soil conditions. As a practical matter, frozen soil conditions make digging holes and accurately observing the soil profile difficult or nearly impossible. Morphological adaptations (such as swollen trunks) and subtle changes in topography also are difficult to observe when deep snow conditions are present.

For these reasons, DEP recommends that BVW delineations be avoided if possible when deep snow cover or "deep freeze" conditions exist. It is best for applicants and conservation commissions to agree upon a reasonable time period for continuing the RDA or NOI processes in order to conduct or review the boundary delineation when frozen or snow covered conditions are likely to change. Because winter delineations are more difficult to do, disagreements - and subsequent appeals - may arise. Avoiding lengthy appeals and disagreements will benefit all parties involved.

When deep snow conditions do not exist, it may be possible to delineate BVW boundaries during the winter by using twigs, buds, leaf scars, and other vegetative indicators.

Winter Wetland Site

Reviewing Boundary Delineations

Reviewing boundary delineations is usually the first step, and quite often the most important part, in effectively administering the Wetlands Protection Act. In the Request for Determination of Applicability (RDA) process, a boundary delineation decision is effective for three years. In the Notice of Intent (NOI) process, a delineation is required to evaluate whether performance standards are being met. The accurate delineation of the BVW boundary is critical to wetlands protection because what may appear to be minor differences in delineation can translate to a substantial amount of wetlands loss (e.g. 20 feet wide x 500 feet long = 10,000 square feet of wetlands loss). Much of the information included in this handbook, especially the procedures, can be applied to the review of proposed BVW boundary delineations.

Information about the BVW boundary delineation should be submitted in NOI or RDA applications. For complex or large sites, applicants should submit plans with a surveyed wetlands line showing the location of numbered flags. The DEP field data form or an explanation of the assessment method used to determine the boundary should always be submitted for complex sites.

For small projects within (or beyond) the 100-foot buffer zone - such as construction of a house where work is limited to the buffer zone - surveyed plans, detailed assessments, and field data forms may not be necessary. In these cases, an assessors map or plot plan with the house location and BVW boundary noted on the plan may be sufficient. In all cases, however, the BVW boundary should be marked in the field.

Conservation commissions are responsible for reviewing the accuracy of an applicant's flagged BVW boundary. In reviewing BVW boundary delineations, conservation commissioners should review all the information that is submitted by the applicant or that is available. Therefore, vegetation must always be reviewed, and indicators of wetlands hydrology must be reviewed as well in those situations where that additional information is submitted. It may be helpful to have the applicant or the applicant's representative present during the site visit to answer questions about the delineation.

There is often much interpretation involved in BVW delineation. In some cases, it may not be possible to precisely locate the wetland/upland boundary and experienced professionals may differ in where they choose to put the line. However, these differences should not be large. Conservation commissions may want to hire a consultant to review delineations in difficult situations. The following are some procedures for reviewing delineations:

1. Before going to the site, review topographic maps, NRCS soils maps, site plans, and other available information so that you are familiar with the site. In particular, look for areas on the maps that might be wetlands but are not included on the site plans provided by the applicant. Make notes of any questions or concerns based on your review of the maps and plans, and ask them at the site visit. Determine which procedure the applicant used to analyze the vegetation. If the dominance test was not used, familiarize yourself with the basic principles and procedures of the methodology that was used to perform the analysis. Review the DEP field data form, when submitted, to become familiar with the vegetation and soils information.

2. Go to the site to review the BVW boundary delineation. Once at the site, walk around the area using the site plans to orient yourself. Is there any evidence that the vegetation or hydrology of the site has been altered? If so, use information in the previous section on delineating BVWs where the hydrology or vegetation has been altered to review the BVW boundary.

3. Once you are well-oriented to the site, walk the BVW boundary as delineated by the applicant. The boundary should be flagged so that when standing at one flag location, the next one is always visible. These flags should be numbered and the numbered flags identified on the site plans.

4. Determine if the BVW boundary in the field matches the plans. If the plans were drawn incorrectly, they should be adjusted accordingly.

5. Determine if the BVW boundary is accurately delineated:

    - If the delineation is based on vegetation alone, review the vegetative community to determine if 50 percent or more of the dominant plants are wetland indicator plants. In addition, look for topographic changes, variations in the herbaceous plant community, or an obvious change in the presence or absence of a specific plant species that is present in the adjacent wetland or upland. If necessary, use other indicators of hydrology.

    - If the delineation is based on vegetation and indicators of hydrology, review the vegetative community to determine if 50 percent or more of the dominant plants are wetland indicator plants. Determine whether hydric soils (or other indicators of hydrology) are present. You can examine the applicant's soil test holes or dig new ones. In addition, look for topographic changes, variations in the herbaceous plant community, or an obvious change in the presence or absence of a specific plant species that is present in the adjacent wetland or upland.

6. If there are questions about the location of the BVW boundary:

    - Ask the person who delineated the boundary to explain their decision in areas where you have questions. Request additional data forms and transects in areas that are disputed based on an on-site assessment. If additional field work is requested for a certain area, the conservation commission should indicate why it has questions or concerns about that portion of the delineation (e.g. the boundary does not appear to reflect a change in the vegetative community in a specific area).

    - If a consensus cannot be reached, the conservation commission may need to decide the location of the BVW boundary. In these circumstances, the commission should adjust the delineation by hanging flags in the field or making notes on the plans (eg. flag #A-12, move 15 feet upgradient). The applicant should show the conservation commission's boundary on the plan.

APPENDIX A
Wetland Indicator Plants Identified in the Massachusetts Wetlands Protection Act
(M.G.L. c. 131, §40)

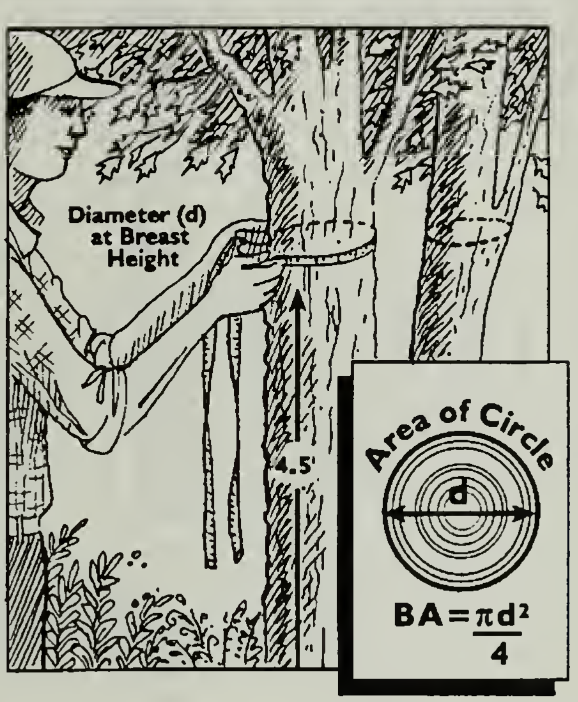
The Wetlands Protection Act lists plants by a common name and one of the following: family name, genus name, or species name. (Note: the species name, also known as the scientific name, is made up of the genus and species.) The list in the Act is general and is not meant to include all plants that occur in wetlands. Also, some plants are listed only by family or genus. These are broad categories that include wetland plants as well as non-wetland plants. For instance, the family Juncaceae is comprised of many rushes of which only some are wetland indicator plants. Also, the genus Fraxinus includes wetland plant species (green ash, *Fraxinus pennsylvanica*; black ash, *Fraxinus nigra)*, as well as a non-wetland plant (white ash, *Fraxinus americana).* As a result, DEP has determined that the plants listed in the Act only by scientific name (plants with a genus and species name) are considered wetland indicator plants. Plants listed in the Act by family or genus only must also be listed in the National List as OBL, FACW+, FACW, FACW-, FAC+ or FAC species to be considered wetland indicator plants. In addition, all plants in the genus *Sphagnum* are considered wetland indicator plants (species in this genus have not yet been categorized by indicator category).

The following plants are listed by scientific name in the Act. (Note: the National List indicator category is included here for reference.)

American or white elm (*Ulmus americana*)	FACW-
aster (*Aster nemoralis*)	FACW+
azalea (*Rhododendron canadense*)	FACW
azalea (*Rhododendron viscosum)*	OBL
black alder (*Ilex verticillata*)	FACW+
black gum tupelo (*Nyssa sylvatica*)	FAC
black spruce (*Picea mariana*)	FACW-
buttonbush (*Cephalanthus occidentalis*)	OBL
cowslip (*Caltha palustris*)	OBL
cranberry (*Vaccinium macrocarpon*)	OBL
hemlock (*Tsuga canadensis*)	FACU
highbush blueberry (*Vaccinium corymbosum*)	FACW-
larch (*Larix laricina*)	FACW
laurel (*Kalmia angustifolia)*	FAC
laurel (*Kalmia polifolia*)	OBL
leatherleaf (*Chamaedaphne calyculata*)	OBL
marsh fern (*Dryopteris thelypteris*)	FACW+
pitcher plants (*Sarracenia purpurea*)	OBL
poison sumac (*Toxicodendron vernix*)	OBL
red maple (*Acer rubrum*)	FAC
sensitive fern (*Onoclea sensibilis*)	FACW
skunk cabbage (*Symplocarpus foetidus*)	OBL
spicebush (*Lindera benzoin*)	FACW-
sweet gale (*Myrica gale*)	OBL
sweet pepper bush (*Clethra alnifolia*)	FAC+
water willow (*Decodon verticillatus*)	OBL
white cedar (*Chamaecyparis thyoides*)	OBL
white Hellebore (*Veratrum viride*)	FACW+

APPENDIX B
Measuring Basal Area

Basal area may be used to estimate percent dominance of trees for vegetative analysis. Trees are woody plants with a diameter at breast height (dbh) of 5 inches or greater and a height of 20 feet or more. Basal area is the cross-sectional area of a tree trunk at breast height (measured 4.5 feet from the ground). To visualize basal area, imagine a tree trunk cut off 4.5 feet above the ground; basal area is the surface area of the top of the stump. Basal area can be added for a number of trees and used like any other unit of measure in analyses of vegetative communities. Trees with multiple trunks that originate below 4.5 feet should be counted as two or more trees (depending on the number of trunks). Each trunk of a multiple trunk tree should be counted separately when determining total basal area for a plant species. For instance, each trunk of a three-trunk red maple would be measured individually to determine basal area for that species.



One method for calculating basal area involves measuring diameter at breast height (dbh) for each tree in a sampling plot and then using a formula for the area of a circle to calculate basal area (basal area = π d^2 $\div$ 4). (Note: π = 3.1416.) Diameter at breast height is measured using a diameter tape or calipers or is calculated from measurements of circumference at breast height (d = circumference $\div$ π). Each conversion of circumference to dbh, or dbh to basal area, must be done separately for each tree trunk before basal areas are added for analysis. See page 54 for a Basal Area Conversion Table that converts circumference (in inches) or dbh (in inches) to basal area (in square inches) for use in vegetative analyses.

Example:
Calculating Basal Area for Trees When the Circumference at Breast Height is Measured

Tree 1 with circumference of 42 inches
diameter = circumference $\div$ π
diameter = 42 $\div$ 3.1416 = 13.37 inches
basal area = π d^2 $\div$ 4
basal area = 3.1416 x (13.37)^2 $\div$ 4 = 140.4 square inches (sq. in.)

Tree 2 with circumference of 31 inches
diameter = 31 inches $\div$ 3.1416 = 9.87 inches
basal area = 3.1416 x (9.87)^2 $\div$ 4 = 76.5 sq. in.

Tree 3 with circumference of 27 inches
diameter = 27 $\div$ 3.1416 = 8.59 inches
basal area = 3.1416 x (8.59)^2 $\div$ 4 = 58 sq. in.

Basal area of all three trees:
140.4 sq. in. + 76.5 sq. in. + 58 sq. in. = 274.9 or 275 sq. in.

See Example #1 in Appendix C to use basal area calculations in a dominance test analysis.

Basal Area Conversion Table

(converts circumference or dbh in inches to basal area in square inches
for use in vegetative analyses; note: $\pi = 3.1416$ for these calculations)

Circumference in Inches	Diameter in Inches	Basal Area Sq. Inches	Circumference in Inches	Diameter in Inches	Basal Area Sq. Inches
15.7	5.0	19.6	71.0	22.6	401.1
16.0	5.1	20.4	72.0	22.9	412.5
17.0	5.4	23.0	73.0	23.2	424.1
18.0	5.7	25.8	74.0	23.6	435.8
19.0	6.0	28.7	75.0	23.9	447.6
20.0	6.4	31.8	76.0	24.2	459.6
21.0	6.7	35.1	77.0	24.5	471.8
22.0	7.0	38.5	78.0	24.8	484.1
23.0	7.3	42.1	79.0	25.1	496.6
24.0	7.6	45.8	80.0	25.5	509.3
25.0	8.0	49.7	81.0	25.8	522.1
26.0	8.3	53.8	82.0	26.1	535.1
27.0	8.6	58.0	83.0	26.4	548.2
28.0	8.9	62.4	84.0	26.7	561.5
29.0	9.2	66.9	85.0	27.1	574.9
30.0	9.5	71.6	86.0	27.4	588.6
31.0	9.9	76.5	87.0	27.7	602.3
32.0	10.2	81.5	88.0	28.0	616.2
33.0	10.5	86.7	89.0	28.3	630.3
34.0	10.8	92.0	90.0	28.6	644.6
35.0	11.1	97.5	91.0	29.0	659.0
36.0	11.5	103.1	92.0	29.3	673.5
37.0	11.8	108.9	93.0	29.6	688.3
38.0	12.1	114.9	94.0	29.9	703.1
39.0	12.4	121.0	95.0	30.2	718.2
40.0	12.7	127.3	96.0	30.6	733.4
41.0	13.1	133.8	97.0	30.9	748.7
42.0	13.4	140.4	98.0	31.2	764.3
43.0	13.7	147.1	99.0	31.5	779.9
44.0	14.0	154.1	100.0	31.8	795.8
45.0	14.3	161.1	101.0	32.1	811.8
46.0	14.6	168.4	102.0	32.5	827.9
47.0	15.0	175.8	103.0	32.8	844.2
48.0	15.3	183.3	104.0	33.1	860.7
49.0	15.6	191.1	105.0	33.4	877.3
50.0	15.9	198.9	106.0	33.7	894.1
51.0	16.2	207.0	107.0	34.1	911.1
52.0	16.6	215.2	108.0	34.4	928.2
53.0	16.9	223.5	109.0	34.7	945.5
54.0	17.2	232.0	110.0	35.0	962.9
55.0	17.5	240.7	111.0	35.3	980.5
56.0	17.8	249.6	112.0	35.7	998.2
57.0	18.1	258.5	113.0	36.0	1016.1
58.0	18.5	267.7	114.0	36.3	1034.2
59.0	18.8	277.0	115.0	36.6	1052.4
60.0	19.1	286.5	116.0	36.9	1070.8
61.0	19.4	296.1	117.0	37.2	1089.3
62.0	19.7	305.9	118.0	37.6	1108.0
63.0	20.1	315.8	119.0	37.9	1126.9
64.0	20.4	325.9	120.0	38.2	1145.9
65.0	20.7	336.2	121.0	38.5	1165.1
66.0	21.0	346.6	122.0	38.8	1184.4
67.0	21.3	357.2	123.0	39.2	1203.9
68.0	21.6	368.0	124.0	39.5	1223.6
69.0	22.0	378.9	125.0	39.8	1243.4
70.0	22.3	389.9	126.0	40.1	1263.4

APPENDIX C
Additional Examples of Vegetation Analysis Using the Dominance Test

Dominance Test Example #1

(using basal area for the tree layer and percent cover for all other layers; species dominant in more than one layer)

Plant species	Scientific name	% Cover	% Dominance	Dominant plant (yes or no)	Wetland indicator category*
<u>Ground Cover</u>					
Interrupted fern	*Osmunda claytoniana*	60	46.2	yes	FAC*
White pine	*Pinus strobus*	45	34.6	yes	FACU
Lowbush blueberry	*Vaccinium angustifolium*	20	15.4	no	
Teaberry	*Gaultheria procumbens*	5	3.8	no	
	Total percent cover:	*130*			
<u>Shrub</u>					
Sweet pepperbush	*Clethra alnifolia*	15	42.9	yes	FAC+*
Glossy buckthorn	*Rhamnus frangula*	15	42.9	yes	FAC*
Gray-stem dogwood	*Cornus foemina*	5	14.3	no	
	Total percent cover:	*35*			
<u>Sapling</u>					
Red maple	*Acer rubrum*	25	83.3	yes	FAC*
White pine	*Pinus strobus*	5	16.7	no	
	Total percent cover:	*30*			

Layers continued, next page

* = Wetland indicator plant

Plant species	Scientific name	Basal area (sq. in.)	% Dominance	Dominant plant (yes or no)	Wetland indicator category*
<u>Tree</u>					
Red maple	*Acer rubrum*	403	48.6	yes	FAC*
White pine	*Pinus strobus*	365	44.0	yes	FACU
Gray birch	*Betula populifolia*	61	7.4	no	
	Total basal area:	*829 sq. in.*			

* = Wetland indicator plant

Dominant plants		Layer	Wetland indicator plant
Interrupted fern	*Osmunda claytoniana*	ground cover	yes
White pine	*Pinus strobus*	ground cover	no
Sweet pepperbush	*Clethra alnifolia*	shrub	yes
Glossy buckthorn	*Rhamnus frangula*	shrub	yes
Red maple	*Acer rubrum*	sapling	yes
Red maple	*Acer rubrum*	tree	yes
White pine	*Pinus strobus*	tree	no

Total number of wetland indicator plants = 5
Total number of non-wetland indicator plants = 2

In this example, percent cover was measured for plant species in the ground cover, shrub, and sapling layers and basal area was calculated for species in the tree layer. Percent dominance was calculated for each species by dividing each species' percent cover by total percent cover for the layer, or basal area by total basal area.

In the ground cover layer, interrupted fern (% dominance = 46.2) does not meet the 50 percent threshold, but the combined total for interrupted fern and white pine does (% dominance = 80.8). Both of these species are considered dominant plants.

Sweet pepperbush and glossy buckthorn are considered dominant plants in the shrub layer because their percent dominance taken together (85.8%), immediately exceeds the 50 percent threshold (neither species exceeds the threshold on its own).

Red maple is the only dominant plant in the sapling layer because its percent dominance (83.3%) exceeds the 50 percent threshold and the other species present in the layer (white pine) has a percent dominance of less than 20 percent.

In the tree layer, the two most abundant species are dominant plants. The most abundant plant alone, red maple, does not have a percent dominance (48.6%) that equals or exceeds 50 percent. However, the combined percent dominance for the two most abundant species does (red maple and white pine).

Red maple is a dominant plant in the tree and sapling layers and white pine is dominant in the tree and ground cover layers. As a result, red maple and white pine are each listed twice in the list of dominant plants.

Even though basal area was used for the tree layer and percent cover for the other three layers, dominant plants from all layers are combined to determine whether 50 percent of the species are wetland indicator plants. In this example, there are seven dominant plants. Five of the seven dominant plants are wetland indicator plants and two are non-wetland indicator plants. Therefore, under the dominance test procedure, the wetland vegetation criterion has been met.

If vegetation alone is presumed adequate for the delineation, the plot is in a BVW. If vegetation alone is not presumed adequate, or to overcome the presumption, other indicators of hydrology also should be used to delineate the BVW boundary. (See Chapter Three.)

Dominance Test Example #2
(using percent cover ranges and midpoint values; one layer with total percent cover less than 5 percent)

Plant species	Scientific name	% Cover	% Dominance	Dominant plant (yes or no)	Wetland indicator category*
Ground Cover					
Ostrich fern	*Matteuccia struthiopteris*	38.0	30.9	yes	FACW*
False nettle	*Boehmeria cylindrica*	38.0	30.9	yes	FACW+*
Devil's beggar-ticks	*Bidens frondosa*	20.5	16.7	no	
Silver maple	*Acer saccharinum*	20.5	16.7	no	
Fringed sedge	*Carex crinita*	3.0	2.4	no	
Cardinal flower	*Lobelia cardinalis*	3.0	2.4	no	
	Total percent cover:	*123.0*			
Shrub					
Silky dogwood	*Cornus amomum*	20.5	100.0	yes	FACW*
	Total percent cover:	*20.5*			
Sapling					
Silver maple	*Acer saccharinum*	3.0	100.0	no	
	Total percent cover:	*3.0*			
Tree					
Silver maple	*Acer saccharinum*	38.0	42.5	yes	FACW*
Eastern cottonwood	*Populus deltoides*	38.0	42.5	yes	FAC*
American elm	*Ulmus americana*	10.5	11.7	no	
Pin oak	*Quercus palustris*	3.0	3.4	no	
	Total percent cover:	*89.5*			

* = Wetland indicator plant

Dominant plants		Layer	Wetland indicator plant
Ostrich fern	*Matteuccia struthiopteris*	ground cover	yes
False nettle	*Boehmeria cylindrica*	ground cover	yes
Silky dogwood	*Cornus amomum*	shrub	yes
Silver maple	*Acer saccharinum*	tree	yes
Eastern cottonwood	*Populus deltoides*	tree	yes

Total number of wetland indicator plants = 5
Total number of non-wetland indicator plants = 0

Plant species were identified and percent cover estimated for each species in each of four layers. Percent cover was visually estimated, therefore, the midpoint values of cover ranges were used to calculate dominance (see page 12 for discussion of cover ranges and midpoints). Percent dominance was calculated for each species by dividing percent cover (midpoints) by total percent cover.

In the ground cover layer, ostrich fern and false nettle are considered dominant plants because their percent dominance taken together (61.8%), immediately exceeds the 50 percent threshold (neither species exceeds the threshold on its own).

Silky dogwood is the only plant species in the shrub layer. The total percent cover for the layer (20.5%) exceeds 5 percent, therefore, the layer is included. Silky dogwood is considered a dominant plant since its percent dominance (100%) exceeds the 50 percent threshold.

Silver maple is the only plant species in the sapling layer. However, the total percent cover for the layer (3%) is less than 5 percent, therefore, the sapling layer is not included in the dominance test.

For the tree layer, silver maple and eastern cottonwood are considered dominant plants because their percent dominance taken together (85%), immediately exceeds the 50 percent threshold (neither species exceeds the threshold on its own).

The area used for this example has five dominant plants. Since all five dominant plants are wetland indicator plants, under the dominance test procedure, the wetland vegetation criterion has been met.

If vegetation alone is presumed adequate for the delineation, the plot is in a BVW. If vegetation alone is not presumed adequate, or to overcome the presumption, other indicators of hydrology also should be used to delineate the BVW boundary. (See Chapter Three.)

Dominance Test Example #3
(using percent cover ranges and midpoint values; several co-dominants in one layer; five layers present)

Plant species	Scientific name	% Cover	% Dominance	Dominant plant (yes or no)	Wetland indicator category*
<u>Ground Cover</u>					
Bracken fern	*Pteridium aquilinum*	10.5	15.9	yes	FACU
Poison ivy	*Toxicodendron radicans*	10.5	15.9	yes	FAC*
Wild geranium	*Geranium maculatum*	10.5	15.9	yes	FACU
Staghorn clubmoss	*Lycopodium clavatum*	10.5	15.9	yes	FAC*
Wild sarsaparilla	*Aralia nudicaulis*	10.5	15.9	yes	FACU
American starflower	*Trientalis borealis*	10.5	15.9	yes	FAC*
Wood anemone	*Anemone quinquefolia*	3.0	4.5	no	
	Total percent cover:	*66.0*			
<u>Shrub</u>					
Witch-hazel	*Hamamelis virginiana*	10.5	43.8	yes	FAC-
Nannyberry	*Viburnum lentago*	10.5	43.8	yes	FAC*
Pink azalea	*Rhododendron periclymenoides*	3.0	12.5	no	
	Total percent cover:	*24.0*			
<u>Sapling</u>					
Eastern hemlock	*Tsuga canadensis*	20.5	100.0	yes	FACU*
	Total percent cover:	*20.5*			
<u>Climbing Woody Vine</u>					
Poison ivy	*Toxicodendron radicans*	10.5	50.0	yes	FAC*
Cat greenbrier	*Smilax glauca*	10.5	50.0	yes	FACU
	Total percent cover:	21.0			

Layers continued, next page

* = Wetland indicator plant

Plant species	Scientific name	% Cover	% Dominance	Dominant plant (yes or no)	Wetland indicator category*
<u>Tree</u>					
Red maple	*Acer rubrum*	38.0	42.5	yes	FAC*
Black birch	*Betula lenta*	20.5	22.9	yes	FACU
White ash	*Fraxinus americana*	20.5	22.9	yes	FACU
White oak	*Quercus alba*	10.5	11.7	no	
	Total percent cover:	*89.5*			

* = Wetland indicator plant

Dominant Plants		Layer	Wetland indicator plant
Bracken fern	*Pteridium aquilinum*	ground cover	no
Poison ivy	*Toxicodendron radicans*	ground cover	yes
Wild geranium	*Geranium maculatum*	ground cover	no
Staghorn clubmoss	*Lycopodium clavatum*	ground cover	yes
Wild sarsaparilla	*Aralia nudicaulis*	ground cover	no
American starflower	*Trientalis borealis*	ground cover	yes
Witch-hazel	*Hamamelis virginiana*	shrub	no
Nannyberry	*Viburnum lentago*	shrub	yes
Eastern hemlock	*Tsuga canadensis*	sapling	yes
Poison ivy	*Toxicodendron radicans*	climbing woody vine	yes
Cat greenbrier	*Smilax glauca*	climbing woody vine	no
Red maple	*Acer rubrum*	tree	yes
Black birch	*Betula lenta*	tree	no
White ash	*Fraxinus americana*	tree	no

Total number of wetland indicator plants = 7
Total number of non-wetland indicator plants = 7

Plant species were identified and percent cover estimated for each species in each of five layers. Percent cover was visually estimated, therefore, midpoint values for the cover ranges were used to calculate dominance (see page 12 for discussion of cover ranges and midpoints). Percent dominance was calculated for each species by dividing percent cover (midpoints) by total percent cover.

In the ground cover layer, six species are co-equal as the most abundant plants in the layer, each with a percent dominance of 15.9 percent. Although only four of these species are required to exceed the 50 percent threshold, all six species are considered dominant plants because they are equally abundant.

In the shrub layer, witch-hazel and nannyberry are considered dominant plants because their percent dominance taken together (87.6%), immediately exceeds the 50 percent threshold (neither species exceeds the threshold on its own).

Eastern hemlock is the only plant species in the sapling layer. Since the total percent cover for the layer (20.5%) exceeds 5 percent, the layer is included. Eastern hemlock is considered a dominant plant since its percent dominance (100%) exceeds the 50 percent threshold. It is also considered a wetland indicator plant since it is a plant species listed in the Wetlands Protection Act.

In the climbing woody vine layer, poison ivy and cat greenbrier are considered dominant plants because each has a percent dominance of 50 percent.

For the tree layer, the most abundant plant alone (red maple) does not exceed the 50 percent threshold. Black birch and white ash are co-equal as the next most abundant species, therefore, both are required to exceed the 50 percent threshold. As a result, red maple, black birch, and white ash are dominant plants in the tree layer.

The area used for this example has 14 dominant plants. Since the number of dominant wetland indicator plants (7) equals the number of dominant non-wetland indicator plants (7), under the dominance test procedure, the wetland vegetation criterion has been met.

If vegetation alone is presumed adequate for the delineation, the plot is in a BVW. If vegetation alone is not presumed adequate, or to overcome the presumption, other indicators of hydrology also should be used to delineate the BVW boundary. (See Chapter Three.)

Dominance Test Example #4
(using percent cover ranges and midpoint values; plants with physiological or morphological adaptations)

Plant species	Scientific name	% Cover	% Dominance	Dominant plant (yes or no)	Wetland indicator category*
Ground Cover					
Sensitive fern	*Onoclea sensibilis*	38.0	100	yes	FACW*
	Total percent cover:	*38.0*			
Shrub					
Highbush blueberry	*Vaccinium corymbosum*	38.0	78.4	yes	FACW-*
Witch-hazel	*Hamamelis virginiana*	10.5	21.6	yes	FAC-
	Total percent cover:	*48.5*			
Sapling					
Red maple	*Acer rubrum*	20.5	50	yes	FAC*
White pine	*Pinus strobus*	20.5	50	yes	FACU
	Total percent cover:	*41.0*			
Tree					
Red maple	*Acer rubrum*	20.5	66	yes	FAC*
White pine	*Pinus strobus*	10.5	33.9	yes	FACU* (shallow roots/ swollen trunks)
	Total percent cover:	*31.0*			

* = Wetland indicator plant

Dominant plants		Layer	Wetland indicator plant
Sensitive fern	*Onoclea sensibilis*	ground cover	yes
Highbush blueberry	*Vaccinium corymbosum*	shrub	yes
Witch-hazel	*Hamamelis virginiana*	shrub	no
Red maple	*Acer rubrum*	sapling	yes
White pine	*Pinus strobus*	sapling	no
Red maple	*Acer rubrum*	tree	yes
White pine	*Pinus strobus*	tree	yes

Total number of wetland indicator plants = 5
Total number of non-wetland indicator plants = 2

Plant species were identified and percent cover estimated for each species in each of four layers. Percent cover was visually estimated, therefore, the midpoint values of cover ranges were used to calculate dominance (see page 12 for discussion of cover ranges and midpoints). Percent dominance was calculated for each species by dividing percent cover (midpoints) by total percent cover.

Sensitive fern is the only plant in the ground cover layer. Since the total percent cover of the layer (38%) exceeds 5 percent, sensitive fern is a dominant plant.

The shrub layer has two plants, highbush blueberry and witch-hazel. Highbush blueberry is a dominant plant since its percent dominance (78.4%) exceeds 50 percent. Witch-hazel also is a dominant plant since its percent dominance (21.6%) exceeds 20 percent.

In the sapling layer, both red maple and white pine have a percent dominance of 50%, therefore each are considered dominant plants.

The tree layer has red maple with percent dominance of 66% and white pine with percent dominance of 33.9%. Each are dominant plants.

In this example, white pine in the tree layer has been identified as a wetland indicator plant since the plants were observed to have shallow roots and swollen trunks. Since these adaptations to wet conditions were observed, these plant species can be considered wetland indicator plants.

The area used for this example has seven dominant plants. Since the number of dominant wetland indicator plants (5) is greater than the number of dominant non-wetland indicator plants (2), under the dominance test procedure, the wetland vegetation criterion has been met.

If vegetation alone is presumed adequate for the delineation, the plot is in a BVW. If vegetation alone is not presumed adequate, or to overcome the presumption, other indicators of hydrology also should be used to delineate the BVW boundary. (See Chapter Three.)

Dominance Test Example # 5
(using percent cover ranges and midpoint values; several co-dominants in one layer)

Plant species	Scientific name	% Cover	% Dominance	Dominant plant (yes or no)	Wetland indicator category*
Ground cover					
Bracken fern	*Pteridium aquilinum*	10.5	15.9	yes	FACU
Poison ivy	*Toxicodendron radicans*	10.5	15.9	yes	FAC*
Wild geranium	*Geranium maculatum*	10.5	15.9	yes	FACU
Staghorn clubmoss	*Lycopodium clavatum*	10.5	15.9	yes	FAC*
Wild sarsaparilla	*Aralia nudicaulis*	10.5	15.9	yes	FACU
American starflower	*Trientalis borealis*	10.5	15.9	yes	FAC*
Wood anemone	*Anemone quinquefolia*	3.0	4.5	no	
	Total percent cover:	*66.0*			
Shrub					
Witch-hazel	*Hamamelis virginiana*	10.5	43.8	yes	FAC-
Nannyberry	*Viburnum lentago*	10.5	43.8	yes	FAC*
Pink azalea	*Rhododendron periclymenoides*	3.0	12.5	no	
	Total percent cover:	*24.0*			
Sapling					
White oak	*Quercus alba*	20.5	100	yes	FACU-
	Total percent cover:	*20.5*			
Tree					
Red maple	*Acer rubrum*	38.0	42.5	yes	FAC*
Black birch	*Betula lenta*	20.5	22.9	yes	FACU
White ash	*Fraxinus americana*	20.5	22.9	yes	FACU
White oak	*Quercus alba*	10.5	11.7	no	
	Total percent cover:	*89.5*			

* = Wetland indicator plant

Dominant plants		Layer	Wetland indicator plant
Bracken fern	*Pteridium aquilinum*	ground cover	no
Poison ivy	*Toxicodendron radicans*	ground cover	yes
Wild geranium	*Geranium maculatum*	ground cover	no
Staghorn clubmoss	*Lycopodium clavatum*	ground cover	yes
Wild sarsaparilla	*Aralia nudicaulis*	ground cover	no
American starflower	*Trientalis borealis*	ground cover	yes
Witch-hazel	*Hamamelis virginiana*	shrub	no
Nannyberry	*Viburnum lentago*	shrub	yes
White oak	*Quercus alba*	sapling	no
Red maple	*Acer rubrum*	tree	yes
Black birch	*Betula lenta*	tree	no
White ash	*Fraxinus americana*	tree	no

Total number of wetland indicator plants = 5
Total number of non-wetland plants = 7

Plant species were identified and percent cover estimated for each species in each of four layers. Percent cover was visually estimated, therefore, the midpoint values for the cover ranges were used to calculate dominance (see page 12 for discussion of cover ranges and midpoints). Percent dominance was calculated for each species by dividing percent cover (midpoints) by total percent cover.

In the ground cover layer, six species are co-equal as the most abundant plants in the layer, each with a percent dominance of 15.9 percent. Although only four of these species are required to exceed the 50 percent threshold, all six species are considered dominant plants because they are equally abundant.

In the shrub layer, witch-hazel and nannyberry are considered dominant plants because their percent dominance taken together (87.6%), immediately exceeds the 50 percent threshold (neither species exceeds the threshold on its own).

White oak is the only plant species in the sapling layer. Since the total percent cover for the layer (20.5%) exceeds 5 percent, the layer is included. White oak is a dominant plant since its percent dominance (100%) exceeds the 50 percent threshold.

For the tree layer, the most abundant plant alone (red maple) does not exceed the 50% threshold. Black birch and white ash are co-equal as the next most abundant species, therefore, both are required to exceed the 50 percent threshold. As a result, red maple, black birch, and white ash are dominant plants in the tree layer.

The area used for this example has 12 dominant plants. Five of the 12 dominant plants are wetland indicator plants, and 7 dominants are non-wetland indicator plants. Since the number of dominant wetland indicator plants is less than the number of dominant non-wetland indicator plants, the wetland vegetation criterion has not been met.

Dominance Test Example #6

(using percent cover ranges and midpoint values; one layer with total percent cover less than 5 percent; with unidentified plant species)

Plant species	Scientific name	% Cover	% Dominance	Dominant plant (yes or no)	Wetland indicator category*
<u>Ground cover</u>					
Ostrich fern	*Matteuccia struthiopteris*	38.0	30.9	yes	FACW*
False nettle	*Boehmeria cylindrica*	38.0	30.9	yes	FACW+*
Species A	?	20.5	16.7	no	
Species B	?	20.5	16.7	no	
Species C	?	3.0	2.4	no	
Species D	?	3.0	2.4	no	
	Total percent cover:	*123.0*			
<u>Shrub</u>					
Silky dogwood	*Cornus amomum*	20.5	100.0	yes	FACW*
	Total percent cover:	*20.5*			
<u>Sapling</u>					
Species X	?	3.0	100.0	no	
	Total percent cover :	*3.0*			
<u>Tree</u>					
Silver maple	*Acer saccharinum*	38.0	42.5	yes	FACW*
Eastern cottonwood	*Populus deltoides*	38.0	42.5	yes	FAC*
American elm	*Ulmus americana*	10.5	11.7	no	
Species Y	?	3.0	3.3	no	
	Total percent cover:	*89.5*			

* = Wetland indicator plant

Dominant plants		Layer	Wetland indicator plant
Ostrich fern	*Matteuccia struthiopteris*	ground cover	yes
False nettle	*Boehmeria cylindrica*	ground cover	yes
Silky dogwood	*Cornus amomum*	shrub	yes
Silver maple	*Acer saccharinum*	tree	yes
Eastern cottonwood	*Populus deltoides*	tree	yes

Total number of wetland indicator plants = 5
Total number of non-wetland indicator plants = 0

Plant species were identified and percent cover estimated for each species in each of four layers. Percent cover was visually estimated, therefore, the midpoint values of cover ranges were used to calculate dominance (see page 12 on discussion of cover ranges and midpoints). Percent dominance was calculated for each species by dividing percent cover (midpoints) by total percent cover.

This example shows that not all plant species need to be identified by name when using the dominance test. If while recording observations, a plant is not recognized, it may be given an identifier (in this example A, B, C, D, X, Y). These plants only need to be identified if they are determined to be dominant plants. If these plants had been included as dominant plants, then a plant identification book or key could have been used to determine the species. Once the species was identified, the National List can be used to determine the indicator category.

In the ground cover layer, ostrich fern and false nettle are considered dominant plants because their percent dominance taken together (61.8%) immediately exceeds the 50 percent threshold (neither species exceeds the threshold on its own).

Silky dogwood is the only plant species in the shrub layer. The percent cover for the layer (20.5%) exceeds 5 percent, therefore, the layer is included. Silky dogwood is considered a dominant plant since its percent dominance (100%) exceeds the 50 percent threshold.

Plant X is the only plant species in the sapling layer. However, the total percent cover for the layer (3%) is less than 5 percent, therefore, the sapling layer is not included in the dominance test.

For the tree layer, silver maple and eastern cottonwood are considered dominant plants because their percent dominance taken together (85%) immediately exceeds the 50 percent threshold (neither species exceeds the threshold on its own).

The area used for this example has five dominant plants. Since all five dominant plants are wetland indicator plants, under the dominance test procedure, the wetland vegetation criterion has been met.

If vegetation alone is presumed adequate for the delineation, the plot is in a BVW. If vegetation alone is not presumed adequate, or to overcome the presumption, other indicators of hydrology also should be used to delineate the BVW boundary. (See Chapter Three.)

APPENDIX D
Glossary

A-horizon: a surface layer of mineral soil darkened by the presence of organic matter; also known as topsoil.

Adventitious roots: roots found on plant stems in positions where roots do not normally occur. These roots may or may not form in response to inundation or saturation.

Aerenchyma: plant tissue that contains large air cells, resulting in a spongy texture.

Aerobic: a condition where free oxygen is present.

Anaerobic: a condition where free oxygen is unavailable.

B-horizon: a zone of weathered mineral soil below the O, A, or E-horizon.

Basal area: the cross-sectional area of a tree trunk measured at breast height (4.5 feet above the ground).

Bordering Vegetated Wetland (BVW): a freshwater wetland that borders a creek, river, stream, pond, or lake; a wetland resource area defined in the Massachusetts Wetlands Protection Regulations (310 CMR 10.55).

Buttressed trunks: the swollen or enlarged bases of trees that develop in response to prolonged inundation.

Capillary fringe: a zone just above the water table that is nearly saturated with water due to capillary action.

C-horizon: A zone of unweathered soil below the A-horizon and, if present, the B-horizon.

Chroma: the relative purity of a color; one of three variables of color.

Climbing woody vine: a vegetative layer that includes woody vines that are attached, rooted, or climbing on trees, saplings, or shrubs.

Concretion: a cemented body of material with internal symmetry such as iron or manganese formed by precipitation of dissolved material; can be removed from the soil intact.

Cover range: a category into which plant species would fit based upon their percent cover.

Diameter at breast height (dbh): the width of a tree trunk as measured at breast height (4.5 feet above the ground).

Dominant plant: based on calculations in the dominance test, a plant determined to be dominant in a particular vegetative layer.

Dominance test: a method of vegetative community assessment based on the number of dominant plants that are wetland indicator plants.

Drift line: an accumulation of water-borne debris often deposited in lines that are roughly parallel to the direction of water flow.

E-horizon: a layer below the O or A-horizon where iron and aluminum oxides and organic matter have been leached out of the soil by organic acids.

Evaporation: loss of water from surface water bodies.

Facultative species (FAC): classification of plants that occur in wetlands 34-66 percent of the time; also known as "fac" species (U.S. Fish and Wildlife Service).

Facultative upland species (FACU): classification of plants that occur in wetlands 1-33 percent of the time; also known as "fac-up" species (U.S. Fish and Wildlife Service).

Facultative wetland species (FACW): classification of plants that occur in wetlands 67-99 percent of the time; also known as "fac-wet" species (U.S. Fish and Wildlife Service).

Fibrist: an organic soil (peat) in which plant remains show very little decomposition and retain their original shape; more than two-thirds of the fibers remain after rubbing the materials between fingers.

Flooded: a condition in which an area is temporarily covered with flowing or standing water.

Gleization: a process in saturated and/or nearly saturated soils which involves the reduction of iron, its segregation into mottles and concretions, or its removal by leaching from the gleyed horizon.

Gleyed: a soil condition resulting from gleization which is characterized by the presence of neutral gray, bluish, or greenish colors in the soil matrix or in mottles among other colors.

Ground cover: a vegetative layer that includes woody vegetation less than 3 feet in height, non-climbing woody vines less than 3 feet in height, and all non-woody vegetation (including mosses) of any height.

Growing season: the portion of the year when soil temperatures are above biologic zero (41 degrees Fahrenheit, 4 degrees centigrade); generally March to November in Massachusetts.

Hemist: organic soils (peaty-mucks and mucky-peats) in which the plant remains show a fair amount of decomposition; between one-third and two-thirds of the fibers are still visible upon rubbing.

Herb: non-woody (herbaceous) plants.

Histic epipedon: contained in a hydric soil with 8-16 inches of organic soil measured from the ground surface.

Histosols: a type of hydric soil with at least 16 inches or more of organic material measured from the ground surface; histosols include fibrists (peats), saprists (mucks) and hemists (peaty-mucks and mucky-peats).

Horizon: a distinct layer of soil generally parallel with the soil surface having similar properties such as color and texture.

Hue: a characteristic of color related to one of the main spectral colors (red, yellow, green, blue, or purple), or various combinations of these principle colors; one of the three variables of color.

Hydric soil: a soil that is saturated, ponded, or flooded long enough during the growing season to cause anaerobic conditions at or near the surface.

Hydrology: the properties, distribution, and circulation of water.

Hydrophyte: any plant that generally grows in water or is adapted to wet conditions; generally the same as wetland indicator plant.

Hypertrophied lenticels: pores on the stem of woody plants which can become swollen or enlarged in response to saturated or inundated conditions.

Inundation: a condition in which water temporarily or permanently covers an area, such as flooding.

Litter: a layer of recently deposited leaves and/or pines needles; may be found above the O-horizon on the forest floor.

Matrix: the undisturbed soil material composed of both mineral and organic matter; matrix color refers to the predominant color of the soil in a particular horizon.

Mineral soil: any soil consisting primarily of mineral material (sand, silt, clay, and gravel) rather than organic matter.

Morphological adaptation: an adaptation that is evident in the form or shape of a plant, such as adventitious roots and aerenchymous tissues.

Mottles: spots or blotches of different color or shades of color interspersed within the dominant matrix color in a soil horizon.

Mucks: organic soils (saprists) in which most of the plant material is decomposed and the original constituents cannot be recognized; less than one-third of the fibers remain visible upon rubbing the materials between fingers.

National List: the U.S. Fish and Wildlife Service's National List of Plant Species That Occur in Wetlands (Reed, 1988).

Nodule: same as concretion but without internal symmetry.

Non-hydric soil: a soil that has developed under predominantly aerobic soil conditions.

O-horizon: a layer of organic soil usually at the surface.

Obligate wetland species (OBL): classification of plants that occur in wetlands greater than 99 percent of the time; also known as "obligate" species (U.S. Fish and Wildlife Service).

Observation plot: a sampling point at which a wetland determination is made.

Organic soil: soil that contains a minimum of 20 percent organic matter when no clay is present or a minimum of 30 percent organic matter when 60 percent or more clay is present.

Oxidation: chemical changes resulting from the presence of oxygen.

Oxidized rhizospheres: oxidized channels and soil surrounding living roots and other underground plant structures.

Parent material: the unconsolidated and more or less weathered mineral or organic matter from which the soil profile is developed.

Peats: organic soils (fibrists) in which plant remains show very little decomposition and retain their original shape; more than two-thirds of the fibers remain after rubbing the materials between fingers.

Percent cover: the percent of the ground surface that would be covered if foliage from a particular species or vegetative layer were projected on the ground, ignoring small gaps between the leaves and branches.

Percent dominance: a measurement calculated by dividing the percent cover for a species by the total percent cover for all species in that layer; a value used in the dominance test.

Percolation: the infiltration of surface water into the ground.

Physiological adaptation: an adaptation of the basic physical and chemical activities that occur in cells and tissues of an organism; generally not observable without the use of specific equipment or tests.

Plant community: the plant populations existing in a shared habitat or environment.

Polymorphic leaves: two or more different types of leaves that form on plants.

Precipitation: water droplets or ice particles condensed from atmospheric water that fall to the earth's surface, such as rain, sleet, or snow.

R-horizon: a layer of hard, unbroken bedrock such as granite, basalt, and quartzite; occurs below all other horizons where present or may have outcroppings of ledge above the surface of the ground.

Reduction: chemical changes resulting from the absence of oxygen.

Sandy: a soil texture of loamy fine sand or coarser that is dominant within 20 inches of the soil surface.

Sapling: a vegetative layer that includes woody vegetation over 20 feet in height with a diameter at breast height (dbh) greater than or equal to 0.4 inches to less than 5 inches.

Saprists: organic soils (mucks) in which most of the plant material is decomposed and the original constituents cannot be recognized; less than one-third of the fibers remain visible upon rubbing the materials between fingers.

Saturated: a condition in which the soil has all or most of its pores within the root zone filled with water.

Scientific name: the name of a plant or animal that is comprised of a genus name and a species name.

Seedling: woody vegetation that is less than 3 feet in height.

Shrub: a vegetative layer that includes woody vegetation greater than or equal to 3 feet but less than 20 feet in height.

Soil: unconsolidated material on the earth's surface that supports or is capable of supporting plants.

Soil profile: vertical section of the soil through all its horizons.

Soil series: a group of soils similar in characteristics and arrangements in the soil profile.

Soil taxonomy: a classification system for soils developed by the U.S. Natural Resources Conservation Service (NRCS).

Soil texture: the relative proportions of the various sizes of particles (silt, sand, and clay) in a soil.

Species name: a Latin form of the name of a plant made up of genus and species; also known as scientific name.

Spodic horizon: in a spodosol, a subsurface layer of soil characterized by the accumulation of aluminum oxides (with or without iron oxides) and organic matter.

Spodosols: soils that possess an E-horizon and spodic horizon due to the leaching of iron and aluminum oxides and organic matter by organic acids.

Stratum: a layer of vegetation used to determine dominant species in a plant community.

Surface water: water present above the substrate or soil surface.

Topography: the position in a landscape, including elevation and change in slope.

Transect: an imaginary line on the ground that bisects a parcel of land along which observations are made or plots established for collecting data (e.g. runs perpendicular to slope or topographic changes in wetland or upland communities).

Transpiration: loss of water from plant surfaces.

Tree: a vegetative layer that includes woody plants greater than or equal to 20 feet in height and with a diameter at breast height (dbh) of 5 inches or greater.

Uplands: non-wetlands.

Upland species (UPL): classification of plants that occur in wetlands less than one percent of the time (U.S. Fish and Wildlife Service).

Value (soil color): the relative lightness or intensity of color; one of the three variables of color.

Vegetative community: the plant populations existing in a shared habitat or environment.

Water mark: a line on vegetation or other upright structures that represent the maximum height reached in an inundation event.

Water table: the upper limit or depth below the surface of the ground that is completely saturated with water.

Wetlands: areas that under normal circumstances have hydrophytic vegetation, hydric soils, and wetland hydrology.

Wetland boundary: a line between an upland and a BVW (as defined at 310 CMR 10.55).

Wetland hydrology: in general terms, permanent or periodic inundation or prolonged saturation sufficient to create anaerobic conditions in the soil.

Wetland indicator category: the frequency with which a plant species occurs in wetlands; categories include obligate wetland, facultative wetland, facultative, facultative upland, and upland (U.S. Fish and Wildlife Service).

Wetland indicator plants: as defined in the Massachusetts Wetlands Protection Regulations: plant species listed in the Wetlands Protection Act; plants in the genus *Sphagnum*; plants in the National List classified as OBL, FACW+, FACW, FACW-, FAC+ and FAC; or any plants demonstrating morphological or physiological adaptations to life in saturated or inundated conditions.

APPENDIX E
Resources

Field Guides

Wetland Plants

Common Marsh, Underwater and Floating-leaved Plants of the United States and Canada by Neil Hotchkiss. 1972. Dover Publications, Inc., New York, NY.

Freshwater Wetlands: A Guide to Common Indicator Plants of the Northeast by D.W. Magee. 1981. University of Massachusetts Press, Amherst, MA.

A Field Guide to Coastal Wetland Plants of the Northeastern United States by R.W. Tiner, Jr. 1987. University of Massachusetts Press, Amherst, MA.

Field Guide to Nontidal Wetland Identification by Ralph W. Tiner, Jr. 1988. Maryland Department of Natural Resources, Annapolis, MD and USFWS.

Plants in Wetlands by Charles B. Redington. 1994. Kendall Hunt Publishing.

Wetlands, Audubon Society Nature Guides by William Neiring. 1987. Alfred A. Knopf, New York, NY.

Trees and Shrubs

A Field Guide to the Trees and Shrubs by G.A. Petrides. 1972. Houghton Mifflin Co., Boston, MA.

The Audubon Society Field Guide to North American Trees: Eastern Region by E.L. Little. 1985. Alfred A. Knopf, Inc., New York, NY.

The Tree Identification Book by G.W.D. Symonds. 1958. Quill, New York, NY.

Trees and Shrubs of New England by Marilyn J. Dwelley. 1980. Down East Books, Camden, ME.

Winter Keys to Woody Plants of Maine by Christopher Campbell and Fay Hyland. University Maine Press, Orno, ME.

Trees of the Eastern and Central U.S. and Canada by W. H. Harlow. 1957. Dover Publications, Inc., New York, NY.

The Shrub Identification Book by G.W.D. Symonds. 1963. William Morrow & Co., New York, NY.

Fruit Key and Twig Key to Trees and Shrubs by W.H. Harlow. 1946. Dover Publications, Inc., New York, NY.

Winter Botany: An Identification Guide to Native Trees and Shrubs by W. Trelease. 1931. Dover Publications, Inc., New York, NY.

Ferns, Clubmosses and Horsetails

A Field Guide to the Ferns and Their Related Families of Northeastern and Central North America by B. Cobb. 1963. Houghton Mifflin Co., Boston, MA.

Wildflowers

Newcomb's Wildflower Guide by L. Newcomb. 1977. Little, Brown & Co., Boston, MA.

A Field Guide to Wildflowers of Northeastern and North Central North America by R.T. Peterson and M. McKenny. 1968. Houghton Mifflin Co., Boston, MA.

The Illustrated Book of Wildflowers and Shrubs by William Carey Grimm. 1993. Stackpole Books, Harrisburg, PA.

The Audubon Society Field Guide to North American Wildflowers: Eastern Region by W.A. Niering and N.C. Olmstead. 1979. Alfred A. Knopf, Inc., New York, NY.

Weeds in Winter by Lauren Brown. 1976. W.W. Norton and Co., New York, NY.

Soils

Munsell Soil Color Charts by Munsell Color. 1975. Macbeth Division of Kollmorgen Corporation, Baltimore, MD. (Available from mail order supply companies.)

Hydric Soils of New England by R.W. Tiner, Jr. and P.L.M. Veneman. 1987. University of Massachusetts Cooperative Extension, Amherst, MA. Bulletin C-183.

Hydric Soils of the United States by U.S.D.A. Natural Resources Conservation Service. 1985. Washington, DC. (Regional and county lists available from NRCS offices, see Appendix H).)

General References

National List of Plant Species that Occur In Wetlands: Massachusetts by P.B. Reed, Jr., 1988. U.S. Fish and Wildlife Service, Washington, DC. (Available from the Massachusetts Association of Conservation Commissions.)

The Concept of a Hydrophyte for Wetland Identification by R.W. Tiner, Jr. 1991. BioScience 41(4):236-247.

"Field Recognition" and "Delineation of Wetlands and Problem Wetlands for Delineation" by R.W. Tiner, Jr., in *Wetlands: Guide to Science, Law, and Technology* by M.S. Dennison and J.F. Berry. 1993. Noyes Publications, Park Ridge, NJ.

Corps of Engineers Wetlands Delineation Manual by Environmental Laboratory. 1987. U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS. Technical Report Y-87-1. (Available from the National Technical Information Service, Springfield, VA, 22161.)

Federal Interagency Committee for Wetland Delineation. 1989. *Federal Manual for Identifying and Delineating Jurisdictional Wetlands.* U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, D.C. Cooperative technical publication.

Use of Vegetation for the Designation of Wetlands by T.R. Wentworth and G.P. Johnson. 1986. U.S. Fish and Wildlife Service, Washington, DC.

Wetland Site Index for Summarizing Botanical Studies by M.C. Michener. 1983. Wetlands 3:180-191.

Estimating Wildlife Habitat Variables by R.L. Hays and W. Seitz. 1981. U.S. Fish and Wildlife Service, Washington, DC. FWS/OBS-81/47.

Maps

DEP Wetlands Conservancy Maps (see Appendix F for contact information).

Soil Surveys: available from U.S.D.A. Natural Resources Conservation Service Offices (formerly Soil Conservation Service Offices) throughout Massachusetts (see Appendix H for contact information).

U.S.G.S. Topographic Maps: available from some bookstores, camping supply stores, and University of Massachusetts Cartographic Information Center.

The following maps and resources are available from Cartographic Information Center, Blaisdell House, University of Massachusetts, Amherst, MA 01003, (phone: 413/545-0359), (fax: 413/545-2304):

- U.S.G.S. Topographic Maps
- National Wetlands Inventory Maps
- DEP Wetlands Conservancy Maps
- Aerial Photographs

Equipment

Some equipment for conducting BVW delineations is available from hardware and department stores. Other items are available from mail order supply companies.

APPENDIX F
Wetlands Conservancy Program Mapping Products

The Department of Environmental Protection's Wetlands Conservancy Program (WCP) is mapping wetlands statewide using aerial photography and photointerpretation. The photos used in this process are **color infrared (CIR) aerial photos** at the 1" = 1,000' scale. The map upon which the wetland delineations are displayed is an **orthophoto map** at the 1" = 417' scale. This extremely accurate map is photo-based and shows all the features of the natural and human-made landscape. The delineations from the CIRs are transferred onto the orthophoto maps.

Wetlands Conservancy Program Map Product Availability

Area	CIR Photos Available	Orthophotos Available
Metro/Suburban Boston	now	now
Buzzards Bay (West Shore)	now	now
MDC Watersheds	now	Spring 1995 (Sudbury, Quabbin, Wachusett)
North Shore	now	1996*
Merrimack Area	now	1996*
Cape Cod Area	now	Fall 1995*
The Islands	now	1995*
Plymouth County	now	1996*
Bristol County	now	1996*

*(Projected availability is subject to change.)

Costs

- orthophoto map: $10 each (on average 5-7 per town)
- color infrared photo (CIR): $15 each (on average 10-12 per town)

For More Information

Charles T. Costello, Section Chief
Wetlands Conservancy Program
Division of Wetlands and Waterways
Department of Environmental Protection
One Winter Street, 8th floor
Boston, MA 02108-4746
Telephone: 617/292-5907

APPENDIX G: DEP Field Data Form and Instructions

The Department of Environmental Protection's field data form should be used when delineating the boundary of a Bordering Vegetated Wetland (BVW) under the Massachusetts Wetlands Protection Act (M.G.L. Chapter 131, Section 40) and regulations (310 CMR 10.55). It should be used whether the boundary is delineated by vegetation alone or by vegetation and other indicators of wetland hydrology. Note: if detailed vegetative assessment is not necessary for the site, make a note on the data form and submit it. The field data form should be submitted with a Request for Determination of Applicability or a Notice of Intent. Details on the criteria for delineating a BVW boundary and the terminology used in this field data form are described in the handbook, *Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act* (MA Department of Environmental Protection, Division of Wetlands and Waterways, 1995).

INSTRUCTIONS

The data form includes a section on project identification, including the applicant's name, the name of the person performing the delineation, project location, and the DEP file number, if available.

If vegetation alone is presumed adequate to delineate the BVW boundary, mark the first box, complete Section I of the data form, and submit the document. If vegetation and other indicators of hydrology are used to delineate the BVW boundary, mark the second box, complete Sections I and II of the form, and submit the document.

DEP has selected the dominance test as the preferred method of vegetation analysis at sample plot locations. The information gathered for that method should be recorded on the form. If a method other than the dominance test is used, mark the third box and explain the method and why it was used.

Section I: Vegetation

Section I should be used to record information about the vegetation within an observation plot and on a transect used to delineate the BVW boundary. Note the date of the delineation. Submit a separate data form for each observation plot. Attach supplemental sheets if more space is needed.

A. Sample Layer and Plant Species

Record each plant species using common and scientific names for the following layers:

<u>Ground Cover</u>: woody vegetation less than 3 feet in height (seedlings), non-climbing woody vines less than 3 feet in height, and non-woody vegetation (including mosses) of any height within a 5-foot radius plot;

<u>Shrubs</u>: woody vegetation between 3 feet and 20 feet in height within a 15-foot radius plot;

<u>Saplings</u>: woody vegetation over 20 feet in height with a diameter at breast height (dbh) greater than or equal to 0.4 inches to less than 5 inches within a 15-foot radius plot; (note: dbh is measured 4.5 feet from the ground);

<u>Climbing woody vines:</u> woody vines that are attached, rooted, or climbing on trees, saplings, or shrubs within a 30-foot radius plot; and

<u>Trees</u>: woody vegetation with a dbh of 5 inches or greater and over 20 feet in height within a 30-foot radius plot.

If you do not recognize a plant species or do not know a plant's name, call it a generic name. Unknown plants need to be identified only if they are determined to be dominant plants. In that case, a plant identification book or key may be used to determine the species.

B. Percent Cover

Determine percent cover (or basal area for trees) for each plant species in each layer by visual analysis or measurement. (See handbook for information about determining percent cover, page 12.)

C. Percent Dominance

Determine percent dominance for each plant species by dividing the percent cover or basal area for each plant species by the total percent cover or basal area for the layer. (See handbook for information about the dominance test, pages 15-19.)

D. Dominant Plants

1. Identify the dominant plants. Dominant plants are:

- plants with a percent dominance of 50 percent or greater, or plants whose percent dominance add up to immediately exceed 50 percent;
- plants with a percent dominance of 20 percent or greater;
- plants with a percent dominance equal to a plant already listed as a dominant species.

2. Determine common and scientific names for any unknown plants identified as dominant plants.

E. Wetland Indicator Category
1. Identify the Wetland Indicator Category for all dominant plant species using the *National List of Plant Species That Occur in Wetlands: Massachusetts.*

2. Use an asterisk to mark the wetland indicator plants. Wetland indicator plants are any of the following:

- plant species listed in the Wetlands Protection Act;
- plants in the genus *Sphagnum*;
- plants listed as Facultative (FAC), Facultative+ (FAC+), Facultative Wetland- (FACW-), Facultative Wetland (FACW), Facultative Wetland+ (FACW+) or Obligate (OBL);
- plants with morphological or physiological adaptations (such as buttressed or fluted trunks, shallow roots, or adventitious roots).

If any plants are identified as wetland indicator plants due to physiological or morphological adaptations, describe the adaptation next to the asterisk (e.g. White pine, *Pinus strobus*, FacU*/shallow roots, buttressed trunks).

Vegetation Conclusion
List the number of dominant wetland indicator plants and the number of dominant non-wetland indicator plants. If the number of dominant wetland indicator plants is equal to or greater than the number of non-wetland indicator plants, and vegetation alone is presumed adequate for the delineation, the plot is located in a BVW.

If vegetation alone has been chosen for the delineation at this site, complete only Section I and submit the form with a Request for Determination of Applicability or a Notice of Intent. Otherwise, continue the delineation process and record information for Section II on the second page of the form.

Section II: Indicators of Hydrology
Section II should be used to record information on indicators of hydrology in those areas where vegetation alone is not presumed adequate to delineate the BVW boundary, or to overcome the presumption that vegetation alone is adequate.

Hydric Soil Interpretation
1. Soil Survey: Record information about the site from the Soil Survey Report prepared by the U.S. Natural Resources Conservation Service (NRCS) - formerly called the Soil Conservation Service.

2. Soil Description: Record information based on observations at a soil test hole located within the vegetation observation plot. Describe the soil profile of each soil horizon, noting the depth. Identify the matrix and mottles colors by hue, value, and chroma (information from Munsell Soil Color Charts). For example, 10YR 5/2. Notes on soil texture and other soil characteristics may be recorded in the Remarks section.

3. Other: note any additional information used to determine if hydric soil is present, such as regional field indicator guides.

Conclusion: Indicate whether the soil is hydric based on information observed in the field. (See list of Hydric Soil Indicators in the handbook, page 29.)

Other Indicators of Hydrology
Record observations of other indicators of hydrology. Check and describe all that apply. Due to their seasonal or temporal nature, these other indicators generally are used in conjunction with vegetation and soils to determine the location of the BVW boundary.

Vegetation and Hydrology Conclusion
Determine if the observation plot is in a BVW. The observation plot is in a BVW if the number of dominant wetland indicator plants is equal to or greater than the number of dominant non-wetland indicator plants, and if hydric soil or other indicators of hydrology are present.

For an observation plot located in a disturbed area, any one of the three indicators is sufficient to determine that the sample location is in a BVW. In that case, make a note on the form about that conclusion.

Submit the completed form with a Request for Determination of Applicability or a Notice of Intent.

DEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Data Form

Applicant:__________ Prepared by:__________ Project location:__________ DEP File #:__________

Check all that apply:

☐ Vegetation alone presumed adequate to delineate BVW boundary: fill out Section I only

☐ Vegetation and other indicators of hydrology used to delineate BVW boundary: fill out Sections I and II

☐ Method other than dominance test used (attach additional information)

Section I. Vegetation

Observation Plot Number:________ Transect Number:________ Date of Delineation:________

A. Sample Layer and Plant Species (by common/scientific name)	B. Percent Cover (or basal area)	C. Percent Dominance	D. Dominant Plant (yes or no)	E. Wetland Indicator Category*

* Use an asterisk to mark wetland indicator plants: plant species listed in the Wetlands Protection Act (MGL c.131, s.40); plants in the genus *Sphagnum*; plants listed as FAC, FAC+, FACW-, FACW, FACW+, or OBL; or plants with physiological or morphological adaptations. If any plants are identified as wetland indicator plants due to physiological or morphological adaptations, describe the adaptation next to the asterisk.

Vegetation conclusion:

Number of dominant wetland indicator plants: **Number of dominant non-wetland indicator plants:**

Is the number of dominant wetland plants equal to or greater than the number of dominant non-wetland plants? yes no

If vegetation alone is presumed adequate to delineate the BVW boundary, submit this form with the Request for Determination of Applicability or Notice of Intent.

MA DEP; 3/95

Section II. Indicators of Hydrology

Hydric Soil Interpretation

1. Soil Survey

Is there a published soil survey for this site? yes no

title/date:

map number:

soil type mapped:

hydric soil inclusions:

Are field observations consistent with soil survey? yes no

Remarks:

2. Soil Description

Horizon	Depth	Matrix Color	Mottles Color

Remarks:

3. Other:

Conclusion: Is soil hydric? yes no

Other Indicators of Hydrology: (check all that apply and describe)

- ☐ Site inundated: ______
- ☐ Depth to free water in observation hole: ______
- ☐ Depth to soil saturation in observation hole: ______
- ☐ Water marks: ______
- ☐ Drift lines: ______
- ☐ Sediment deposits: ______
- ☐ Drainage patterns in BVW: ______
- ☐ Oxidized rhizospheres: ______
- ☐ Water-stained leaves: ______
- ☐ Recorded data (stream, lake, or tidal gauge; aerial photo; other) : ______

______

- ☐ Other: ______

Vegetation and Hydrology Conclusion

	yes	no
Number of wetland indicator plants $\geq$ number of non-wetland indicator plants	☐	☐
Wetland hydrology present:		
hydric soil present	☐	☐
other indicators of hydrology present	☐	☐
Sample location is in a BVW	☐	☐

Submit this form with the Request for Determination of Applicability or Notice of Intent.

APPENDIX H
Contact Information

Department of Environmental Protection/Division of Wetlands and Waterways

Questions about the Wetlands Protection Act and regulations can be directed to wetlands staff in DEP's Boston office and four regional offices.

Boston Office

One Winter Street
8th floor
Boston, MA 02108
(617) 292-5695
Fax (617) 556-1049

Carl Dierker, Acting Director
Robert Golledge, Acting Deputy Director
Michael Stroman, Asst. Program Chief, Wetlands Protection Program
Richard Tomczyk, Regional Coordinator, Wetlands Protection Program

Central Regional Office

75 Grove Street
Worcester, MA 01605
(508) 792-7650
Fax (508) 792-7651
Philip Nadeau, Section Chief, Wetlands Protection Program

Northeast Regional Office

10 Commerce Way
Woburn, MA 01801
(617) 932-7600
Fax (617) 932-7615
James Sprague, Section Chief, Wetlands Protection Program

Southeast Regional Office

20 Riverside Drive
Lakeville, MA 02347
(508) 946-2800
Fax (508) 947-6557
Elizabeth Kouloheras, Section Chief, Wetlands Protection Program

Western Regional Office

State House West, 4th Floor
436 Dwight Street
Springfield, MA 01103
(413) 784-1100
Fax (413) 784-1149
Robert McCollum, Section Chief, Wetlands Protection Program

Wetlands Conservancy Program (for map information)

One Winter St., 8th floor, Boston, MA 02108
Charles Costello, Section Chief
(617) 292-5907

Department of Environmental Management

Department of Environmental Management
Division of Water Resources
Flood Management
Leverett Saltonstall Building
100 Cambridge Street
Boston, MA 02202
(617) 727-3268

Federal Emergency Management Agency

Federal Emergency Management Agency
Natural and Technological Hazards Division
Room 462
J.W. McCormack Building
Boston, MA 02109
(617) 223-9561

Massachusetts Association of Conservation Commissions (MACC) and MACC West

Massachusetts Association of Conservation Commissions (MACC): Main Office
Sally A. Zielinski, Executive Director
10 Juniper Road
Belmont, MA 02178
(617) 489-3930

Massachusetts Association of Conservation Commissions: Western Outreach Office
Alexandra D. Dawson, Esq., Coordinator
2 West Street
Hadley, MA 01035
(413) 584-2724

Massachusetts Society of Municipal Conservation Professionals

Massachusetts Society of Municipal Conservation Professionals
Brian Monahan, President
P.O. Box 274
Concord, MA 01742
(617) 270-1656

U.S. Army Corps of Engineers

United States Army Corps of Engineers
New England Division
Regulatory Division
424 Trapelo Road
Waltham, MA 02254-9149
(800) 362-4367 (from within Massachusetts)
(800) 647-8862 (from outside Massachusetts)

U.S. Environmental Protection Agency

United States Environmental Protection Agency
Region 1 (Northeast)
Wetlands Protection Section
JFK Federal Building
Boston, MA 02203
(617) 565-4868

U.S. Natural Resources Conservation Service Field Offices and District Conservationists (formerly called the Soil Conservation Service)

State Headquarters
451 West Street
Amherst, MA 01002-2927
(413) 253-4350
Cecil Currin, State Conservationist

Barnstable Field Office (serving the Cape Cod, Dukes, and Nantucket Conservation Districts)
Flintrock Road
P.O. Box 709
Barnstable, MA 02630
(508) 362-9332
Donald W. Liptack, District Conservationist

Greenfield Field Office (serving the Franklin Conservation District)
55 Federal Street
Hayburne Building, Room 270
Greenfield, MA 01301
(413) 772-0384
Diane Leone, District Conservationist

Holden Field Office (serving the Northeastern, Northwestern, and Southern Worcester Conservation Districts)
The Medical Arts Center Building
52 Boyden Road
Holden, MA 01520-2587
(508) 829-6628
Ronald E. Thompson, District Conservationist

Northampton Field Office (serving the Hampden and Hampshire Conservation Districts)
Potpourri Mall
243 King Street, Room 39
Northampton, MA 01060
(413) 586-5440
Angel Figueroa, District Conservationist

Pittsfield Field Office (serving the Berkshire Conservation District)
Silvio Conte Federal Building
78 Center Street (Arterial)
Pittsfield, MA 01201
(413) 443-6867
Mark W. Grennan, District Conservationist

West Wareham Field Office (serving the Bristol, Norfolk, and Plymouth Conservation Districts)
15 Cranberry Highway
West Wareham, MA 02576
(508) 295-7962
Leonard R. Reno, Jr., District Conservationist

Westford Field Office (serving the Essex, Middlesex, and Suffolk Conservation Districts)
319 Littleton Road, Room 205
Westford, MA 01886
(508) 692-1904
Daniel J. Lenthall, District Conservationist

University of Massachusetts, Cooperative Extension System

University of Massachusetts Cooperative Extension
212 Stockbridge Hall
University of Massachusetts
Amherst, MA 01003-0099
(413) 545-4800

(Please call this number for all agent and departmental referrals.)

Appendix I

Wetlands Protection Regulations (310 CMR 10.55)

(Please note these regulations take effect on June 30, 1995.)

10.55: Bordering Vegetated Wetlands (Wet Meadows, Marshes, Swamps and Bogs)

(1) Preamble. Bordering Vegetated Wetlands are likely to be significant to public or private water supply, to ground water supply, to flood control, to storm damage prevention, to prevention of pollution, to the protection of fisheries and to wildlife habitat.

The plants and soils of Bordering Vegetated Wetlands remove or detain sediments, nutrients (such as nitrogen and phosphorous) and toxic substances (such as heavy metal compounds) that occur in run-off and flood waters.

Some nutrients and toxic substances are detained for years in plant root systems or in the soils. Others are held by plants during the growing season and released as the plants decay in the fall and winter. This latter phenomenon delays the impacts of nutrients and toxins until the cold weather period, when such impacts are less likely to reduce water quality.

Bordering Vegetated Wetlands are areas where ground water discharges to the surface and where, under some circumstances, surface water discharges to the ground water.

The profusion of vegetation in Bordering Vegetated Wetlands acts to slow down and reduce the passage of flood waters during periods of peak flows by providing temporary flood water storage and by facilitating water removal through evaporation and transpiration. This process reduces downstream flood crests and resulting damage to private and public property. During dry periods the water retained in Bordering Vegetated Wetlands is essential to the maintenance of base flow levels in rivers and streams, which in turn is important to the protection of water quality and water supplies.

The Act defines freshwater wetlands by hydrology and vegetation. Hydrology is the driving force which creates wetlands, but it is a transient, temporal parameter. The presence of water at or near the ground surface during a significant portion of the year supports, and in fact promotes, the growth of wetland indicator plants. Prolonged or frequent saturation or inundation also produces hydric soils, and creates anaerobic conditions that favor the growth of wetland indicator plants. Hydric soils are direct indicators of long-term hydrologic conditions and are present throughout the year.

Wetland vegetation supports a wide variety of insects, reptiles, amphibians, small mammals and birds which are a source of food for important game fish. Bluegills (*Lepomis macrochirus*), pumpkinseeds (*Lepomis gibbosus*), yellow perch (*Perca flavescens*), rock bass (*Ambloplites rupestris*) and all trout species feed upon nonaquatic insects. Large-mouth bass (*Micropterus salmoides*), chain pickerel (*Esox niger*) and northern pike (*Esox lucius*) feed upon small mammals, snakes, nonaquatic insects, birds and amphibians.

Wetland vegetation provides shade which moderates water temperatures important to fish life. Wetlands flooded by adjacent water bodies and waterways provide food, breeding habitat and cover for fish. Fish populations in the larval stage are particularly dependent upon food provided by over-bank flooding which occurs during peak flow periods (extreme storms) because most river and stream channels do not provide sufficient quantities of the microscopic plant and animal life required for food.

Bordering vegetated wetlands are probably the Commonwealth's most important inland habitat for wildlife. The hydrologic regime, plant community composition and structure, soil composition and structure, topography, and water chemistry of bordering vegetated wetlands provide important food, shelter, migratory and overwintering areas, and breeding areas for many birds, mammals, amphibians and reptiles. A wide variety of vegetated wetland plants, the nature of which are determined in large part by the depth and duration of water, as well as soil and water composition, are utilized by varied species as important areas for mating, nesting, brood rearing, shelter and food (directly and indirectly). The diversity and interspersion of the vegetative structure is also important in determining the nature of its wildlife habitat. Different habitat characteristics are used by different wildlife species during summer, winter and migratory seasons.

10.55: continued

Although the vegetational community can often be analyzed to establish an accurate wetland boundary, sole reliance on the presence of wetland indicator plants can be misleading because some species thrive in both uplands and wetlands. Gently sloping areas often produce large transitional zones where the vegetational boundary is difficult to delineate. Hydrology can supplement vegetative criteria to enhance the technical accuracy, consistency, and credibility of wetland boundary delineations, and are especially useful for analyzing disturbed sites.

(2) Definition, Critical Characteristics and Boundary.

(a) Bordering Vegetated Wetlands are freshwater wetlands which border on creeks, rivers, streams, ponds and lakes. The types of freshwater wetlands are wet meadows, marshes, swamps and bogs. Bordering Vegetated Wetlands are areas where the soils are saturated and/or inundated such that they support a predominance of wetland indicator plants. The ground and surface water regime and the vegetational community which occur in each type of freshwater wetland are specified in M.G.L. c. 131, § 40.

(b) The physical characteristics of Bordering Vegetated Wetlands, as described in 310 CMR 10.55(2)(a), are critical to the protection of the interests specified in 310 CMR 10.55(1).

(c) The boundary of Bordering Vegetated Wetlands is the line within which 50% or more of the vegetational community consists of wetland indicator plants and saturated or inundated conditions exist. Wetland indicator plants shall include but not necessarily be limited to those plant species identified in the Act. Wetland indicator plants are also those classified in the indicator categories of Facultative, Facultative+, Facultative Wetland-, Facultative Wetland, Facultative Wetland+, or Obligate Wetland in the National List of Plant Species That Occur in Wetlands: Massachusetts (Fish & Wildlife Service, U.S. Department of the Interior, 1988) or plants exhibiting physiological or morphological adaptations to life in saturated or inundated conditions.

1. Areas containing a predominance of wetland indicator plants are presumed to indicate the presence of saturated or inundated conditions. Therefore, the boundary as determined by 50% or more wetland indicator plants shall be presumed accurate when:

a. all dominant species have an indicator status of obligate, facultative wetland+, facultative wetland, or facultative wetland- and the slope is distinct or abrupt between the upland plant community and the wetland plant community;

b. the area where the work will occur is clearly limited to the buffer zone; or

c. the issuing authority determines that sole reliance on wetland indicator plants will yield an accurate delineation.

2. When the boundary is not presumed accurate as described in 310 CMR 10.55(2)(c)1.a. through c. or to overcome the presumption, credible evidence shall be submitted by a competent source demonstrating that the boundary of Bordering Vegetated Wetlands is the line within which 50% or more of the vegetational community consists of wetland indicator plants and saturated or inundated conditions exist. The issuing authority must evaluate vegetation and indicators of saturated or inundated conditions if submitted by a credible source, or may require credible evidence of saturated or inundated conditions when determining the boundary. Indicators of saturated or inundated conditions sufficient to support wetland indicator plants shall include one or more of the following:

a. groundwater, including the capillary fringe, within a major portion of the root zone;

b. observation of prolonged or frequent flowing or standing surface water;

c. characteristics of hydric soils.

3. Where an area has been disturbed (*e.g.* by cutting, filling, or cultivation), the boundary is the line within which there are indicators of saturated or inundated conditions sufficient to support a predominance of wetland indicator plants, a predominance of wetland indicator plants, or credible evidence from a competent source that the area supported or would support under undisturbed conditions a predominance of wetland indicator plants prior to the disturbance.

10.55: continued

(3) Presumption. Where a proposed activity involves the removing, filling, dredging or altering of a Bordering Vegetated Wetland, the issuing authority shall presume that such area is significant to the interests specified in 310 CMR 10.55(1). This presumption is rebuttable and may be overcome upon a clear showing that the Bordering Vegetated Wetland does not play a role in the protection of said interests. In the event that the presumption is deemed to have been overcome, the issuing authority shall make a written determination to this effect, setting forth its grounds (Form 6, 310 CMR 10.99).

(4) General Performance Standards.

(a) Where the presumption set forth in 310 CMR 10.55(3) is not overcome, any proposed work in a Bordering Vegetated Wetland shall not destroy or otherwise impair any portion of said area.

(b) Notwithstanding the provisions of 310 CMR 10.55(4)(a), the issuing authority may issue an Order of Conditions permitting work which results in the loss of up to 5000 square feet of Bordering Vegetated Wetland when said area is replaced in accordance with the following general conditions and any additional, specific conditions the issuing authority deems necessary to ensure that the replacement area will function in a manner similar to the area that will be lost:

1. the surface of the replacement area to be created ("the replacement area") shall be equal to that of the area that will be lost ("the lost area");
2. the ground water and surface elevation of the replacement area shall be approximately equal to that of the lost area;
3. The overall horizontal configuration and location of the replacement area with respect to the bank shall be similar to that of the lost area;
4. the replacement area shall have an unrestricted hydraulic connection to the same water body or waterway associated with the lost area;
5. the replacement area shall be located within the same general area of the water body or reach of the waterway as the lost area;
6. at least 75% of the surface of the replacement area shall be reestablished with indigenous wetland plant species within two growing seasons, and prior to said vegetative reestablishment any exposed soil in the replacement area shall be temporarily stabilized to prevent erosion in accordance with standard U.S. Soil Conservation Service methods; and
7. the replacement area shall be provided in a manner which is consistent with all other General Performance Standards for each resource area in Part III of 310 CMR 10.00.

(c) Notwithstanding the provisions of 310 CMR 10.55(4)(a), the issuing authority may issue an Order of Conditions permitting work which results in the loss of a portion of Bordering Vegetated Wetland when;

1. said portion has a surface area less than 500 square feet;
2. said portion extends in a distinct linear configuration ("finger-like") into adjacent uplands; and
3. in the judgment of the issuing authority it is not reasonable to scale down, redesign or otherwise change the proposed work so that it could be completed without loss of said wetland.

(d) Notwithstanding the provisions of 310 CMR 10.55(4)(a),(b) and (c), no project may be permitted which will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.59.

(e) Any proposed work shall not destroy or otherwise impair any portion of a Bordering Vegetated Wetland that is within an Area of Critical Environmental Concern designated by the Secretary of Environmental Affairs under M.G.L. c. 21A, § 2(7) and 301 CMR 12.00. This 310 CMR 10.55(4)(e):

1. supersedes the provisions of 310 CMR 10.55(4)(b) and (c);
2. shall not apply if the presumption set forth at 310 CMR 10.55(3) is overcome;
3. shall not apply to work proposed under 310 CMR 10.53(3)(l); and
4. shall not apply to maintenance of stormwater detention, retention, or sedimentation ponds, or to maintenance of stormwater energy dissipating structures, that have been constructed in accordance with a valid order of conditions.